Instruments

THE MAGAZINE OF

Measurement and Control

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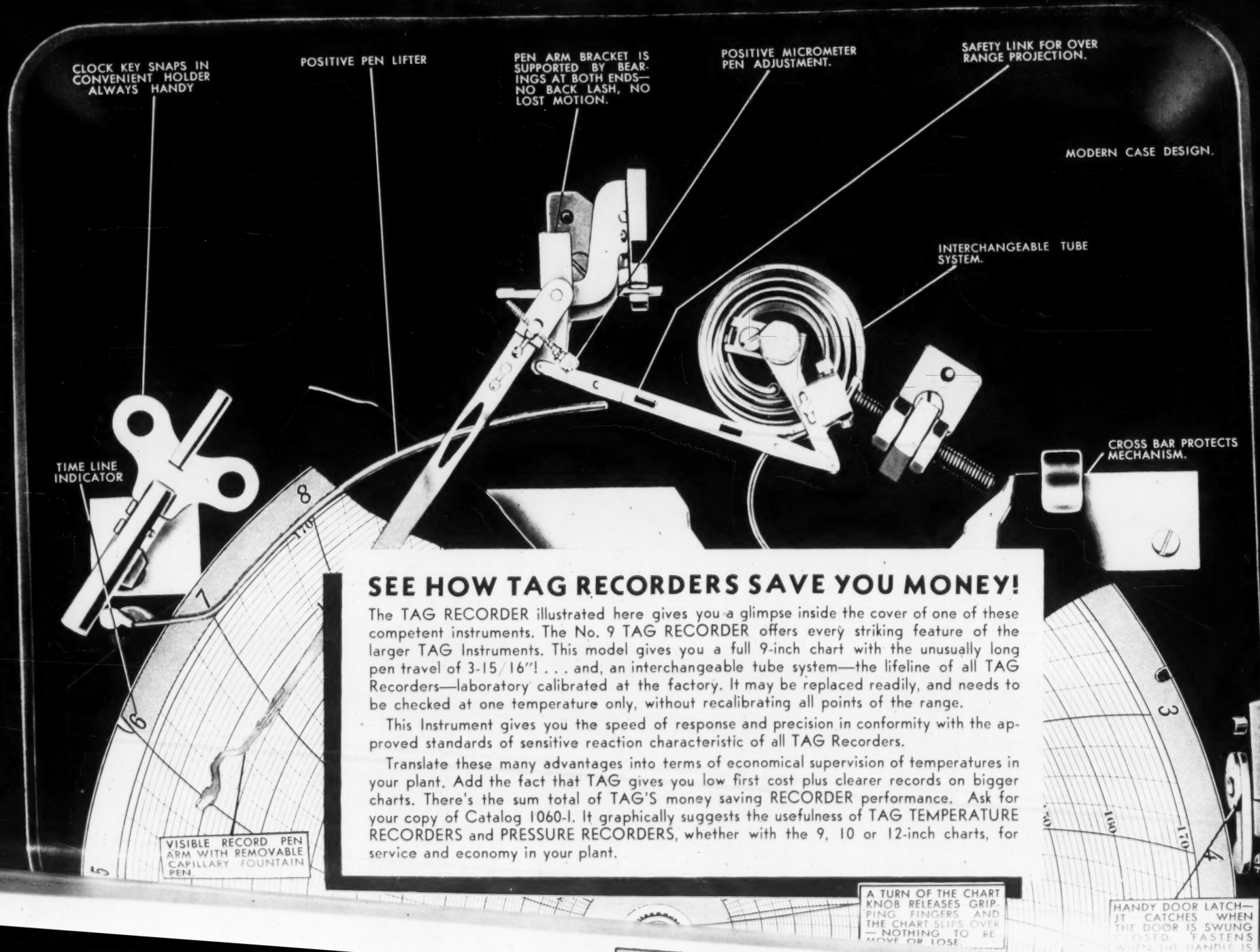
SPECIAL ISSUE :: :: IN TWO PARTS

PART ONE

INSTRUMENTS SAVE MONEY

INSIDE THE COVER . . .


CLOCK KEY SNAPS IN CONVENIENT HOLDER ALWAYS HANDY
POSITIVE PEN LIFTER
PEN ARM BRACKET IS SUPPORTED BY BEARINGS AT BOTH ENDS—NO BACK LASH, NO LOST MOTION.
POSITIVE MICROMETER PEN ADJUSTMENT.
SAFETY LINK FOR OVER RANGE PROJECTION.
MODERN CASE DESIGN.
INTERCHANGEABLE TUBE SYSTEM.
CROSS BAR PROTECTS MECHANISM.
TIME LINE INDICATOR
VISIBLE RECORD PEN ARM WITH REMOVABLE CAPILLARY FOUNTAIN PEN.
A TURN OF THE CHART KNOB RELEASES GRIPPING FINGERS AND THE CHART SLIPS OVER—NOTHING TO REMOVE OR LOSE.
HANDY DOOR LATCH—IT CATCHES WHEN THE DOOR IS SWUNG CLOSED. FASTENS WHEN THE HANDLE IS

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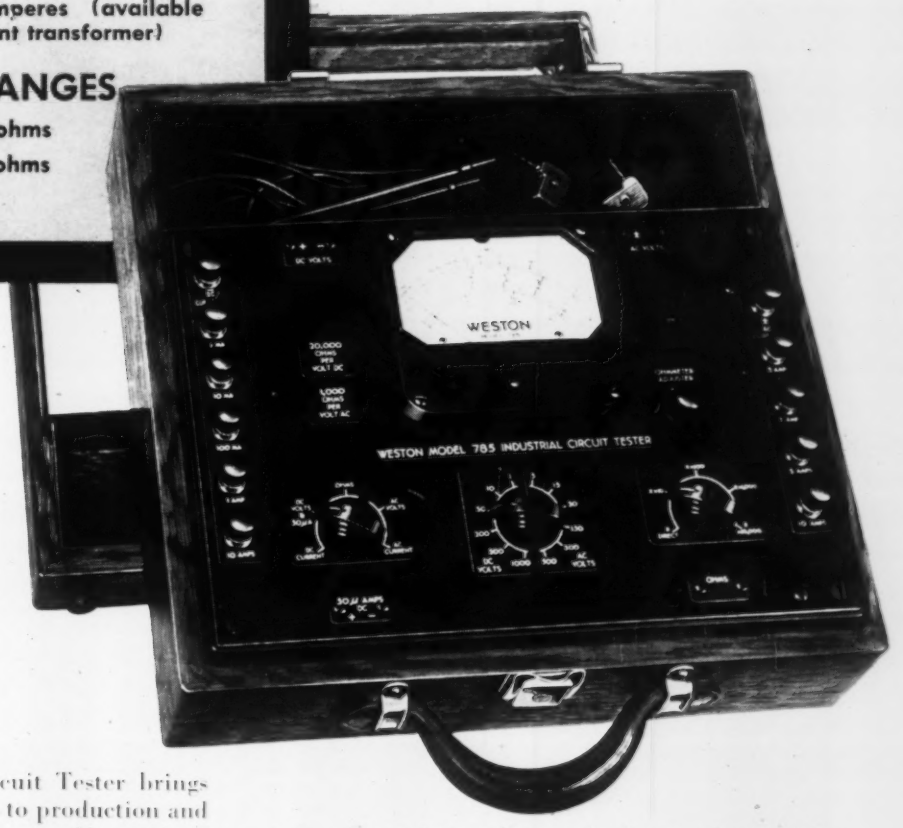

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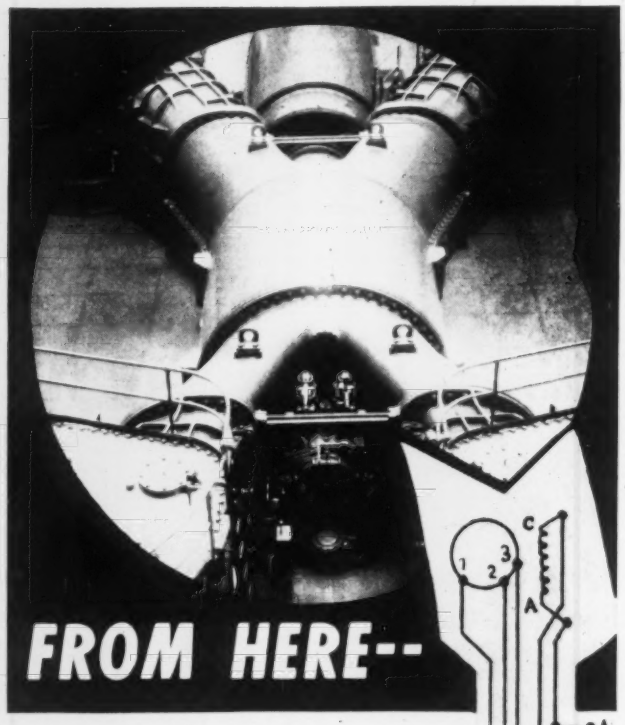

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Instruments

THE MAGAZINE OF MEASUREMENT and CONTROL

Vol. XIII JANUARY 1940 No. 1

SPECIAL ISSUE—IN TWO PARTS

(Part Two, bound separately, is **The 1940 Instruments Index**)

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Instruments

THE MAGAZINE OF *Measurement and Control*

M. F. BEHAR, Editor

("Instruments Save Money") = ("Instrumentation Makes Jobs")

IN the Presidential Message to Congress, on January 3d, there was listed as a national problem —to be dealt with by government—the creation of new jobs faster than new machines eliminate jobs. Since the President is a lawyer by profession, this brief paragraph represents a major victory for the anti-machine propagandists. *They*—in effect—wrote it!

Some day—and let us hope it is not in the remote future—a President will, in his Message to Congress on the State of the Union, urge that inventions and improved machines be encouraged in order to prevent a return to the "old days" (the present time) when millions of men willing to work could not find work, chiefly because neither the people nor their government understood the beneficial potentialities of Automaticity.

Some day a Chief Executive will—frequently and as a matter of course—advocate the extension of every means that tends to reduce the sum total of human drudgery, for then it will be understood that Automaticity is a *pure* blessing when it is not interfered with by pressure groups.

This special issue of *Instruments* is dedicated to this ideal—not in spite of the fact that its main themes are saving money and making jobs, but precisely in accordance with these two themes.

These two themes are intimately related to each other. "Money" is here used as the commonly-accepted measure of the solvency of any enterprise: Whether we think of the enterprise as a lone bachelor cultivating a small isolated farm without any hired help, or whether we think of it as a railroad system, communications system or integrated manufacturing corporation, the value of this enterprise —its value to the nation as well as to itself—depends on minimizing wasted human effort. A fair measure of this accomplishment is "saving money."

The isolated farmer who uses modern instead of primitive methods, and thereby saves money, is not likely to become a public charge even in old age. Moreover, if he is resourceful, he will invest his money savings in more money-saving implements and provide employment for others.

In the case of an industrial firm, "money saving" has a proportionately greater influence upon the creation of new jobs. Outlawed forever are the Get-Rich-Quick Wallingfords who put the firm's money in their own pockets. Today the most successful industrial leaders are those who recognize, proclaim and obey the valid doctrines of success, summarized in such slogans as "more goods for more people at less cost."

Instruments save money because they reduce the sum total of human drudgery and thereby make possible the creation of new jobs.

Instrumentation creates jobs because it saves money.

Simple, isn't it?

Perhaps too simple. Wherefore it is recommended that you read this special issue through and through. Some of the prize-winning articles are specific case studies; others broad surveys; others general dissertations—but all contain impressive facts and irrefutable arguments. We wish that every high personage in the executive and legislative branches of the federal and of all state governments would study this special issue from cover to cover.

Our reference to the recent Presidential message has nothing to do with controversies between political parties or within any political party. We *must* take notice of it because every Message on the State of the Union, since 1789, has been a historic document, always representing a sincere attempt to deal with national problems in a non-partisan spirit, usually prepared with the aid of eminent advisors from both parties. Brief though it was, this anti-machine paragraph is now a part of America's official history.

The pity of it! And to think that much of the "technological unemployment" nonsense dinned into our President's ears comes from the mouths of degree-laden "scientists" who have worked themselves into White House favor!

No use weeping, though: there are jobs to be done. The first is one of counter-propaganda. Everyone of us who derives his bread-and-butter from Technology must, at every opportunity, fervently argue in favor of drudgery-eliminating machines; and patiently explain that in *every* modern industry these devices create *more* employment, indeed, that they help create new industries. This job *Instruments* has been doing and so have other publications, various organizations and many individuals, but not enough! The other job to be done, of course, is one of practical politics, but we are unacquainted with this art and can only suggest that true representatives of science and technology should strive for influence in government.

Report on Second Annual Instrumentation Contest

Sponsored by the Industrial Instruments Section, Scientific Apparatus Makers of America

IN compliance with the Announcement and Contest Rules promulgated in August 1939, the Jury of Award met on Thursday, December 7, 1939, in the Hotel Commodore, New York City. The following were present:

OFFICIALS: P. T. Sprague, Chairman of the Industrial Instruments Section, S.A.M.A.; and Richard Rimbach, Publisher of *Instruments*, Conductor of the Contest.

JURY OF AWARDS: M. F. Béhar, Editor, *Instruments;* C. S. Redding, President, Leeds & Northrup Co.; H. B. Richmond, Treasurer, General Radio Co.; P. T. Sprague, President, The Hays Corporation; F. K. Taylor, Vice-Pres., Taylor Instrument Companies.

Mr. Sprague opened the session, announced with regret the absence of Jury of Award members L. G. Wilson and Clemann Withers, and called upon the Conductor of the Contest to turn over to the Jury all of the manuscripts received under the Rules. This was done.

Copies of the Rules were distributed. Mr. Redding slowly read aloud the complete text of the Rules. After a brief discussion, all members of the Jury declared themselves to be completely in accord on all interpretations.

The Conductor of the Contest had caused all entries received either at the office of the S.A.M.A. or at the office of the Instruments Publishing Co., to be bound uniformly, each in a 9" x 12" manila folder. Each entry was identifiable only by its serial number. Under Paragraph 7 of the Rules, the title of each manuscript was either "Theme I" or "Theme II" and its subject either "Instruments Save Money" or "Instrumentation Makes Jobs."

The first hour was devoted to a cursory examination of entries, by all members present, in order that each member might mentally formulate a scale of values to be applied later when carefully grading each entry.

This done, the entries were passed in rotation systematically, and each entry was, after careful reading, graded by each member according to Paragraph No. 5 of the Rules:

5. The judges' rating will be based upon the following factors:

Pertinency of factual data (Closeness to the selected theme)	40
Value of information presented (Breadth of *applicability* to problems faced by various industries)	20
Breadth of scope of subject-matter	10
Timeliness, novelty, originality, etc.	10
Effectiveness of presentation	20
Total	100

Early in the afternoon, this grading was completed, and a quick survey of the results disclosed the interesting fact that exactly twelve entries stood out: The score of the twelfth, although only a trifle below that of the eleventh, was far above that of the thirteenth.

This was a fortunate outcome, for it assured that the winners of the twelve prizes, sharing the $500 fund donated in 1939 by the Industrial Instruments Section, had submitted relatively superior manuscripts. That is to say, these twelve were far more meritorious than the greater number of non-winners.

Another result of the tabulation was that a particular manuscript (a case study reporting hundreds of thousands of dollars saved by instruments costing $500) was unquestionably the first choice—not only in total credit points but also in the opinion of every individual member. In other words, each member gave this manuscript a far higher rating than he gave any other. This is mentioned because one or two of the judges could not help recognizing the notable work described.

This tabulation showed also almost a three-way tie for second place. The three manuscripts in question were therefore re-read and critically discussed. Result, an even closer race for second place! Ultimately, the account of actual happenings in a sugar refinery received a slightly higher final total grading than the polished and erudite dissertation on underlying concepts. As to the entry which lost out for Third Prize though leading the other Fourth Prizes . . . see if you can "spot" it! (The four Fourth Prize essays are printed in *Instruments* in alphabetical order of authors' names.)

The remainder of the session was devoted to similar critical reconsiderations of manuscripts which came close to the line between Fourth and Fifth, but the final totals made no difference. (The five Fifth Prize essays, likewise, are printed in alphabetical order.)

When the sealed envelopes were opened, disclosing identities of authors, members were gratified to note the variety of occupations and industries represented by the contestants.

A number of manuscripts failed to win high marks because (apparently) they were written without any understanding of the Contest Rules. For example, there was a sumptuously bound manuscript, beautifully typed on heavy paper, accompanied by high-class drawings and photographs, which described in profuse detail a laboratory set-up for conducting a certain type of investigation. We judges all felt genuinely sorry for the author, because an entry like that represents a week or so of preparation, without counting the years of research which led to the invention of the apparatus described, but under Paragraph 5 of the Contest Rules this manuscript could only be given a maximum of 30% by each member.

Other non-winning contestants had interesting stories to tell but did not tell them. Eight or ten entries ran to about 150 or 200 words each—without any tables, diagrams or photographs. They were merely the "makings" of manuscripts that would have received favorable consideration if the authors had taken pains. It is true that the Rules allowed only 20% for "effectiveness of presentation," but even if this 20% for neatness, style, adequacy, etc. had been left out, the final results of the Contest would have been about the same.

—MFB

Theme	Type of entry	Field covered	Winner
		FIRST PRIZE, $200	
I	Case study	Control of purchased power	William B. Skinkle, Carnegie-Illinois Steel Co., Pittsburgh, Pa.
		SECOND PRIZE, $100	
I	Case study	Recorders in sugar industry	Dan Gutleben, Chief Engineer, Pennsylvania Sugar Co., Philadelphia, Pa.
		THIRD PRIZE, $50	
I	Essay	General principles	William H. Pezold, Bureau of Vocational Activities, Board of Education, City of New York.
		FOUR FOURTH PRIZES OF $25 EACH	
II	Statistical	General; also power	R. F. Boyer, Physicist, The Dow Chemical Co., Midland, Mich.
I	Case study	Rubber adhesives	William J. Crehan, Chemist, Baldwin Rubber Co., Pontiac, Mich.
II	Essay	General; also telephone company	Philip Robert Ewald, T.V.A. Fertilizer Works, Wilson Dam, Ala.
I	Essay	Savings in energy consumption	Ralph Rand, The Texas Company, Casper Works, Casper, Wyo.
		FIVE FIFTH PRIZES OF $10 EACH	
I	Case study	Water leak detection	Fred A. Gurdes, Municipal engineer, Oak Park, Ill.
I	Case study	Capacitor manufacture	M. Kevelson, Engineer, Solar Mfg. Corp., Bayonne, N. J.
II	Case study	New jobs in steel plant	F. E. McClure, Otis Steel Co., Cleveland, Ohio.
I	Case study	Rubber thickness gages	H. Olken, Junior Electrical Engineer, Navy Dept, Washington, D. C.
II	Essay	Product quality improves business	Erwin H. Waldman, Andrews Steel Co., Newport, Ky.

His name is William Baldwin Skinkle but they fondly call him "Bill." One reason looks at you from the center of this piece. The portrait, you would say, is that of a veteran who befriends novices, a sage who guides the unwary. Right! They call him "Bill" fondly—and respectfully!

Born in 1882 in Washington, D.C., Bill started as a machinist at sixteen, and has worked ever since. But the face, you say, is that of a scholar. Right again! It's this way: Bill never went to day high school, but he studied evenings; passed the Carnegie Tech entrance exams in 1912 and for seventeen years attended Tech evening courses, obtaining B.S. in M.E., then M.E., then M.Sc.

Daytime, too, he was having more and more important jobs assigned to him by U. S. Steel, with which he has been since 1905. The number and variety of these past and present jobs defies condensation. Suffice it to mention that in 1918 he was the first man requisitioned by name by the Army for designing and building what would have become the world's largest arsenal if the Armistice whistle hadn't blown. Though 57 years old chronometrically, Bill is about 40 biometrically—as witness this really new (Dec. 20, 1939) portrait.—MFB.

Demand Control Reduces Power Costs

By W. B. SKINKLE

Secretary and Engineer, Pittsburgh District Power Committee, Subsidiary Companies of U. S. Steel Corporation, Pittsburgh, Pa.

ELECTRICAL energy is sold by public utilities to industrial plants under rate schedules which, though lengthy and complex as published, may be described in simple language as contracts which impose extra charges for excessively high loads of relatively short duration. Momentary overloads can be handled by the "flywheel effects" of generating systems and by the initial heat-dissipating rates of transmission and distribution systems. Therefore, the meters used for billing purposes are so designed and adjusted that (again using simple language) they "disregard" extreme overloads which only last a fraction of a second and which do not recur more often than at five-minute intervals. On the other hand, these meters never fail to register any high load which lasts for more than, say, one minute and which therefore imposes an unusual *demand* on the lines, transformers and other facilities all the way back to the generating stations. In the United States the usual *demand interval* is fifteen minutes.

The proprietor of a small woodworking shop, bakery, etc., who can literally keep his eyes on all his machines, can possibly keep down his monthly power bills by issuing simple instructions and seeing to it that they are carried out. Few such small customers actually take this "trouble." Those who do are amply rewarded: the reduction in power costs may amount to 20% or more, depending on the types of power-consuming equipment and on the inflexible sequences of operations.

In medium-size and large industrial plants it is physically impossible for a single man to control loads without instrumental aids: he cannot be everywhere at once. It is of course in medium and large plants that the reductions in power costs effected by installing power control instrumentation exceed by far the few hundred dollars' cost of the instruments. The writer ventures to lay down as a general rule that the larger the plant, the greater the *percentage* of reduction in power costs which is reported after the installation of power control instrumentation. The writer bases this general rule on twenty years of experience, which have shown that in order to effect the greatest possible reductions, there are required not only the physical installation of a load control room (or desk) but adequate personnel adequately trained—two requirements which are more easily met in a large plant than in a small plant. These matters will become evident in the following case study.

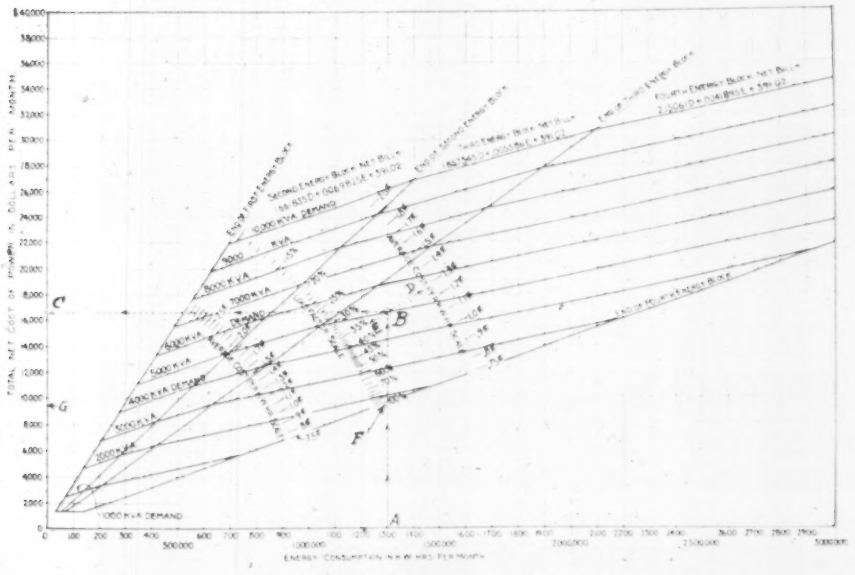

Fig. 1. Graphic representation of a typical rate schedule.

The rate schedule of almost any public utility company can be subjected to exact mathematical and graphical analysis. Fig. 1 is a typical rate graph, where total cost of power in dollars per month is used as the ordinates, and energy consumption in kw. per month as the abscissa. The family of lines shows how the monthly power bill increases with continued use of energy at some particular demand.

The chart shows (*A-B-C*) that if 1,300,000 kwh. of energy (*A*) were purchased during a given month at a demand of 5000 kva. (*B*), the resulting power bill would have been about $16,600 for the month (*C*). The chart also shows that had this number of kwh. been purchased under ideal conditions of 100% load factor (intersecting at *F* instead of at *B*), the demand would have decreased from 5000 kva. to slightly less than 2,000 kva., and the power bill for that month would have decreased from $16,600 to about $9500 as shown at *G*—a reduction of about $7100, or 43%.

While the use of energy under such perfect conditions is impracticable, efforts to approach perfection will result in substantial cost reductions.

The usual method of determining the demand imposed on a utility by a customer is through a recording demand meter which draws a series of arcs at regular time intervals. The length of any arc, when multiplied by the proper "meter constant," determines the kw. or kva. demand during that particular interval. The longest of these arcs in a given month is usually the base on which the demand charge is calculated. This demand charge ranges anywhere from $1.00 to $2.50 per kw. per month; it frequently constitutes anywhere from 40% to 75% of the total power bill.

Fig. 2 exemplifies conditions before control of demand and timing of production. It is made up of reproductions of short sections of six monthly demand records that set the monthly demand charges on a particular plant. It covers the worst six months of a given year.

A study of that plant indicated that the required production could be maintained without undue trouble or interruption at 2,400 kw. demand. This controlled demand is indicated by the dot-and-dash lines. Following is a detailed discussion of conditions disclosed by Fig. 2:

Some plant managers start "campaigns" toward the end of each month and insist that their department heads "get that order out and into this month's business." It only takes a glance at chart section A, at the top of Fig. 2, to visualize such a "campaign" in this Works, and the response to the pressure. False economy, through poor timing, is evident. The areas represented by the demand lines above the "controlled demand" did not increase the plant production for the month by more than a small fraction of 1%, but the excess demand thus created increased the monthly power bill by $2,200. It is doubtful whether the total sale price of the added production equalled the increase in the power bill!

The other chart sections show similar increases in power costs:

(B) A 1½ hour peak added $2,430 to the month's bill.

(C) A 1¾ hour peak added $3,105 to the month's bill.

(D) A "good" day's production added $2,430 to the bill.

(E) A short-time peak due to a turbine break-down when the entire load was thrown onto the utility added $5,130 to the month's bill, and most of this was added during one hour of the peak. The energy shown in the peak was calculated and divided into the increase in cost due to the peak. This extra energy was found to have cost nearly $1.19 per kwh.

(F) A peak of only 1½ hours added $4,725 to the month's bill.

Now let us examine the sensational results accomplished by installing a few relatively simple devices.

A standard demand limiter costing approximately $300 was installed on the incoming utility power lines, and some standard time switches costing about $30 each were installed near the heating furnaces. The demand device sounded a siren near the end of the demand interval (in this case

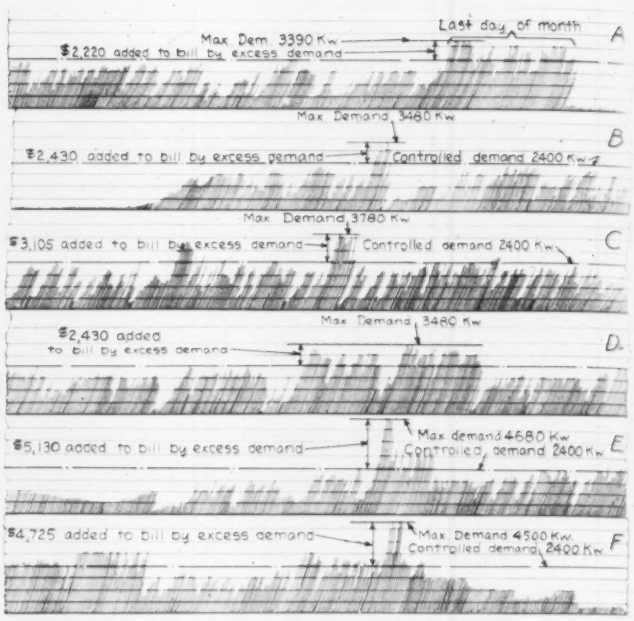
Last day of month
A
Max Dem 3390 Kw
$2,220 added to bill by excess demand
Max Demand 3480 Kw
B
$2,430 added to bill by excess demand
Controlled demand 2400 Kw
Max Demand 3780 Kw
C
$3,105 added to bill by excess demand
Controlled demand 2400 Kw
Max Demand 3480 Kw
D
$2,430 added to bill by excess demand
$5,130 added to bill by excess demand
Max demand 4680 Kw
Controlled demand 2400 Kw
E
$4,725 added to bill by excess demand
Max Demand 4500 Kw
Controlled demand 2400 Kw
F

Fig. 2

15 minutes) whenever the demand threatened to pass a predetermined maximum that had been set by the plant officials at the beginning of the month as sufficient to carry the expected production for that month. The time switches flashed a red light at the heating furnaces so that the heater would draw blooms not in excess of the maximum rate at which they could be handled by the sequence of mills that formed the material, and in this way prevent partly rolled product from lying on the run-out tables and cooling during the rolling process.

The chart sections in Fig. 3 show the results.

The first three 72-hour records show demands for typical months immediately preceding the installation of the control instruments. The bottom three-day record is typical of demands for the first month the control equipment was in operation.

Owing to some special load conditions, it suddenly became necessary to rush the installation, which was not completed until late the night of the 31st of the month, and it was placed in regular operation early the next morning. One demand interval "got away from" the operators on the second day, as indicated by the note on the chart. The maximum demand was, however, reduced from 1890 kw. for the preceding month to 900 kw. for the first month that the demand limiter and switches were in service. Another interesting feature was that on the preceding month the mill using 1890 kw. of demand had 15,000 lbs. of scrap, while under the controlled demand of 900 kw. the mill cut its scrap loss in half.

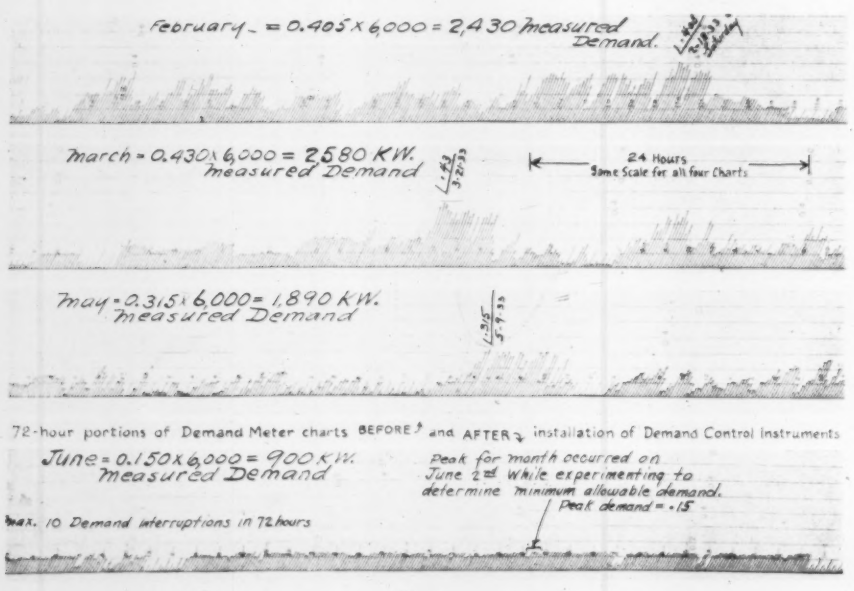
February = 0.405 x 6,000 = 2,430 measured Demand.
March = 0.430 x 6,000 = 2580 KW. measured Demand
24 Hours
Same Scale for all four Charts
May = 0.315 x 6,000 = 1,890 KW. measured Demand
72-hour portions of Demand Meter charts BEFORE and AFTER installation of Demand Control Instruments
June = 0.150 x 6,000 = 900 KW. measured Demand
Peak for month occurred on June 2nd while experimenting to determine minimum allowable demand.
Peak demand = .15
Max. 10 Demand interruptions in 72 hours

Fig. 3

Incidentally, a careful estimate showed that a $500 total investment in instrumentation kept close to $7000 off that plant's power bill that first month.

By the end of the first year, about $78,600 had been kept off the costs.

Work of reducing these power costs continued, and at the end of the second year a careful estimate indicated that approximately $170,800 had been kept off power costs for that year. This last larger cost reduction was due to a large increase in business and a considerable extension of motorized units in the works, which resulted in over 50% increase in the use of electric energy.

Demand control devices of this type are now standard equipment in all of this corporation's plants making any considerable purchases of utility power.

Fig. 1

Control of Demand in Actual Practice

Pictorial Supplement to W. B. Skinkle's Prize-winning Article, photographed for *Instruments* by U.S. Steel Corp.

VISITORS are seldom admitted to demand-control rooms of large plants, especially in busy times when production sequences must be controlled to fractions of a minute. However, *Instruments* is privileged to escort you (*via* camera) into the modern sound-proof demand-control room just installed at the new Irvin Works of U.S. Steel. Standing in back of the operator's chair you first note (Fig. 1) the Irvin Works demand limiter D_1, remote-control system demand limiter D_2, and signal lights *SL* actuated by demand meters. Then, in Fig. 2 (a close-up of D_1), you witness a "dramatic" moment: Time hand *T* indicates that the demand interval is almost up; and "actual demand" pointer *A* is close to "ideal demand" pointer *I*, the rate of which has been set by means of mechanism *M* as directed by plant officials at the beginning of each month.

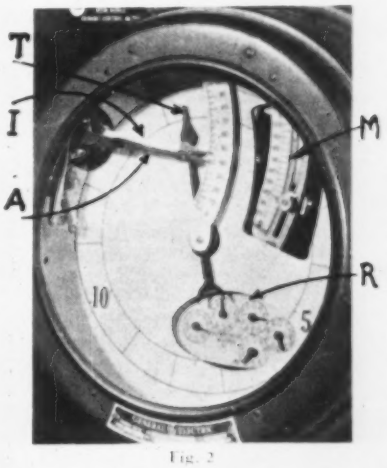

Fig. 2

Although the operator cannot be everywhere at once, he overlooks the mill floor through windows *W* (Fig. 1); and his means of communication are as follows: seven hand-operated switches (Fig. 1) for signaling the chief power-consuming units; a plant loud-speaker system, of which *C* is the volume control and *LS* the loud speaker for return messages; transmitter T_1 for calling all main power-consuming units; telephone station T_2 for calls over Bell lines; a private-line telephone (not shown) to the power company's load dispatcher; and the Works dial 'phone (not shown) for inter-department calls.

In easy view of the operator are the recorders shown in Fig. 3, recording plant department demands and loads. On another panel in the room are (Fig. 4) two more demand-recorders and a water supply recorder used for control of pumphouse operations.

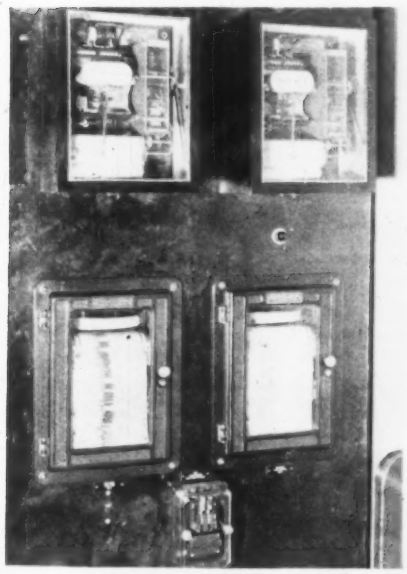

Fig. 3

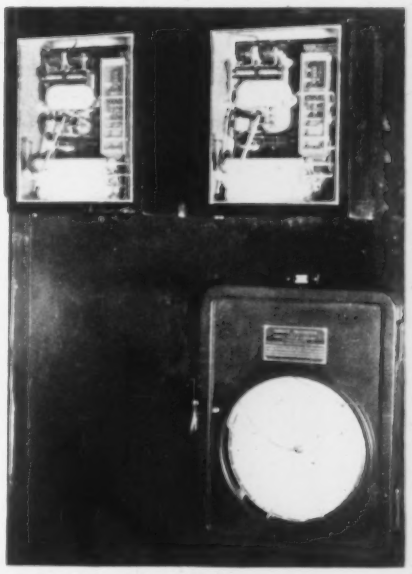

Fig. 4

Instrument Savings? Peek into my Diary!

By DAN GUTLEBEN
Chief Engineer, Pennsylvania Sugar Co., Philadelphia, Pa.

SECOND PRIZE

USUALLY, the conventional *raison d'être* for recording instruments is sufficient to justify their cost. Sometimes they earn their keep by standing guard like a policeman even though they never make a move. Their presence commands respect! Our sand filters are back-washed with boiling water which is discharged to the sewer. For a number of months the steam flowmeter showed an unreasonable flow of steam to the water heater and this was suspected to be due to the forgetfulness of the operator in allowing the hot water to by-pass to the sewer. Surreptitiously, the instrument man installed a recording thermometer in the sewer outlet. Immediately, the unusual steam demand ceased and the thermometer recorded no waste of hot water. Evidently, the operator had "smelled a rat."

In 1927, six thousand dollars' worth of flowmeters were installed in the pan steam lines and in numerous other stations for the purpose of accumulating data for use in the design of the inevitable new steam plant. The sugar boilers at first resented this under the thought that the instruments were "stool pigeons," but gradually the men observed that there was a connection between the movement of the pen and their control of the steam, water and liquor valves. The meaning of a pound of steam was explained in terms of coal and money. Now the rate of steam flow is used by the sugar boilers as an indication of the status of the strike. The heat transmission decreases as the viscosity increases. Just after graining, the steam consumption rises suddenly since the saturation degree of the liquor is reduced by the crystallization of some of the sugar. "Zucker Kocker" Jake recently reminisced and confided to the Commentator that their original resentment had long since been changed into a high regard for the usefulness of the meters.

The records are useful in pointing out errors of operation, thereby preventing repetitions of these errors. They also show up operation forgetfulness or careless operation —not carried out in accordance with instructions.

On August 11, the heat exchanger thermometer showed a high waste water temperature and a low heat exchange. On investigation it was found that the by-pass valve for the waste water from Char House No. 1 was open. This by-passed the heat exchanger so as to waste the heat. "Instrumental Joe," the record keeper, said he had noticed on July 13 that the demand for steam for heating filtered water rose and he had "told the foreman." The temperature recorder on the Pan floor told the whole story but nobody had heeded it. It showed only half of the usual rise in the heat imparted to the fresh water.

During the month, from mid-July to mid-August, that the hot waste water by-passed the heat exchanger, the flowmeters recorded 6,980,000 pounds of steam required to heat 31,213,000 gallons of water. During the previous month, 4,413,000 pounds of steam heated 31,384,000 gallons. The loss due to thoughtlessness was 2,500,000 pounds of steam = $500 worth of coal. Inspection of the sand filter supply tank on the 9th floor showed that somebody had propped the float valve open so that the cold water continually flowed into this tank to mix with the warm seal water. No reason can be found for this deed. We were heating cold river water instead of using the warm water from the condensers.

On September 25, when the House was down, the recording thermometer record showed the raw water entering the heat exchanger in the Char House to have a temperature of 125° against a river water temperature of 75°. This indicated that the hot water tank was allowed to overflow into the sand filter receiving tank and thus to reduce the effectiveness of the exchanger. A telephone call to the Superintendent brought about the correction. This used to occur frequently and was finally stopped when a meter was installed in the overflow pipe. The meter never had a chance to produce a tell-tale record: the operator sensed its purpose and watched the pump so as to avoid the overflow.

Recently a flowmeter was installed in the steam line to the new Schutte & Koerting ejector vacuum pump. The meter showed that the sugar boilers did not shut off the steam when the pan was not in use. When the plant shut down on Thursday night the steam valve was left open and wasted 150-pound steam continuously till it was accidentally discovered on Saturday night.

In a "post mortem investigation" (after the "death" of a piece of equipment) recording meters provide facts to explain occurrences that would otherwise remain mysteries. The cause of the failure of a blade in the power turbine in June remained unknown until a careful examination of the boiler steam-flow and water-level records brought out the following: Due to the failure of the reducing-valve oil pump, and to the subsequent erroneous hand operation, the boiler steam production at first dropped from 150,000 pounds per hour to 75,000 and then instantly rose to 240,000, while the water level rose from the average of 6" to 21". This, evidently, had caused a carry-over of water into the turbine. Cost of damage $1,600.

"After receiving his A.B. from Nebraska U. in 1900, the Commentator started at rung number one on a beet sugar house construction job. The first task was accompanied by an old Stackpole surveying instrument that had many years before dodged the arrows from ambushed Indians along the Union Pacific frontier.

"The 1900 style of beet sugar factory was operated under the benefit of mercury thermometers and dial pressure gages and no other instruments outside of the laboratory. The only integrator in the plant was a counter which summarized the number of 900-lb. dumps of an automatic beet scale. Now and then, due to the rivalry between the day shift and the night, an operator surreptitiously tripped the lever and thus recorded one dump to the credit of his shift! Later, the time-cycle graph made this practice obsolete.

"The entire boiler house control was left to the steam gage and the railroad company's bills-of-lading. After steam flowmeters came into the field, relative efficiencies were exposed and the leaks plugged.

"The performances of the new plants were reported to guide the designers in next year's models. These early reports were exasperations because of the lack of important measured ingredients. Twenty-five years ago, crude graphs of boiler steam flow came to the engineer's desk but nobody else was interested. Sometimes large steam valves were thoughtlessly opened even after the week-end shut-down of most of the boilers. The resultant disturbances were loaded on the blameless fireman and the graphs were accused of possessing the human quality of prevarication. Because of prejudice by both operators and apropriators, the first flowmeters were tacked unsuspectingly onto important equipment purchases, just as in Washington some pork is concealed under an occasional vital appropriation. Subsequently, both the 'Old Man' and the Accounting Department acknowledged the institution of meters as their own idea and, in deference to the cause, Good Saint Peter must certainly have condoned the means!

"This instrumental biography parallels the progress from a roving crew of constructors to the goal of Engineer!

"With reference to the cash prize, my 'complex' does not demand remuneration for doing a service for the fellows. In my younger days I used to absorb information and sponge on the older men who exposed their experiences in the technical journals. Now, if my experiences can profit others, it's a moral obligation to 'ante' them into the general pot!"

Basic Concepts of Instrument Savings

THIRD PRIZE

By WILLIAM HENRY PEZOLD

Bureau of Vocational Activities, Board of Education, City of New York

IN the search for help in solving the problems that beset us in our own particular business, there comes a time when resort must be made to the fundamental thinking abilities and reasoning procedures stored away in our individual minds. Past experience has supplied facts, data, and cases in infinite profusion, most of them faded by now, but leaving behind them the mellowed traces of their existence in the form of a network of mental concepts. The solutions to our difficulties, if achieved, are obtained by syntheses of temporally distinct conditions that are linked by common principles or common concepts. The inescapable inference is that our most valuable thinking processes are those of generalization in method beyond the boundaries of specific cases, through the use of aspects appearing in all. Examination of the fields of industrial as well as theoretical science indicates the powerful possibilities of generalized principles in the solution of specific problems. In dynamics, the equations of Lagrange and Hamilton employing generalized coördinates yield quick and elegant solutions.[1] In problems of stress analyses, the general equations as developed by Love, Timoshenko, and others are readily adaptable to specific cases by competent engineers.[2] In essence, our industrial problems are quite common in nature, they merely deal with functional systems appearing in different contents which are solvable by basically similar treatment.

The relationship of profit to excellence of solution in a technical problem is, however, often indeterminate in nature. In general the assumption must be made that with respect to controllable variables, money is gained or saved in an industrial operation when the project or processes concerned most nearly conform to fundamental technical concepts. When conditions imposed by technical needs are cleverly met, the saving of money is to be regarded as a normal consequence. The questions now arise as to the nature of these controlling concepts and technical needs that form the operational genera of industrial activities, and, as to the role of instruments in their functioning.

The foundations of most of our industrial production are determined by definitions and standards. There are fundamental and derived units, primary, secondary and commercial standards, legal and technical definitions without number. Basic standards are often only intelligible through the use of instruments; in fact, many standards and definitions can only assume tangible form through the use of specially designed instruments.[3] When the nature of the work to be done involves such needs, the use of instruments is not a matter of financial discretion, but of financial necessity.

Next in importance to standards ranks duplication as a generalized concept. Duplication is in essence a problem of comparison. We compare machine parts for interchangeability, colors for dyes, propeller blades for balance, and bullets for characteristic markings. Since comparisons can be made with varying degrees of precision, it is commonly assumed that instruments should be employed only for operations involving a high degree of accuracy. This is an erroneous assumption. An instrument saves money in duplication because it achieves sufficient accuracy for the need, because it routinizes the process, and because it usually diminishes the influence of subjective elements.

Instruments reveal ultra-sensory perceptions to us. In many of the more complex industrial processes and products there are active variables of high order, which, if discovered, yield considerable profit and, if hidden, cause great loss. Magnetic methods quickly reveal flaws in railroad rails, and stroboscopes reveal the nature of high-speed vibrations in machinery. The seismograph will plot an underground oilpool, and the polariscope, through photoelastic methods, the stress distribution in an engineering structure. The use of such instruments to extend the perceptions is not to be regarded as the last resort of a difficult situation but, again, as a normal way of making use of the general concept concerned—that of seeking and finding.

In all problems concerning a series of elements occurring as a sequence of events and involving relationships of cause and effect, the degree of coördination achieved is an index of economic efficiency. Effective coördination requires, first, an original layout or plan that is reasonable and elastic enough to accommodate emergencies. Beyond this there must be continuous or periodic checking for general supervisory purposes, a quick and accurate means for determining the cause, nature, location, magnitude, and method of correction for dislocations, and an effective procedure for returning the system to equilibrium. Instruments can do many of these things for us automatically, or semi-automatically, relieving minds from routine and permitting the application of time and thought to creative achievement. In numerous processes, remote control features can be incorporated providing grouped or centralized supervision, while continuous and intermittent recording devices compile indisputable records for administrative purposes. Where a complete process is composed of both continuous and discontinuous operations, improved coördination through instrumentation in the continuous portions will usually provide favorable conditions for economy in the others. Truly, the reduction to practice of the fundamental concept of coördination, with its inevitable savings, is effectively achieved through instrumental control.

William H. Pezold, M.E. (Stevens, 1928) and M.S. (Michigan, 1936), is a graduate also of the New York State course for industrial teachers. He was first employed (1928) by the Curtiss Aeroplane and Motor Co. as an airplane designer and stress analyst, working on problems of control surface vibrations and landing gear impact effects. In 1931 he joined the Aircraft Improvement Corp. as chief stress analyst. Here he worked on wind-tunnel experiments with multiple-slot wings, photoelastic analysis of fittings, and what is believed to be the design and deflection tests of the first American adaptation of the Steiger mono-spar wing. Since 1935 he has taught applied physics in the New York City technical schools and is now assigned as advisor on shop supervision, equipment, and preparation of budget. He is 32.

In the discussion of our topic "Instruments save money," the cost of our instruments lurks like Banquo's ghost amidst the noble array of discoverable virtues. Although in some instances the amount saved through use of instruments has been negligible, in many other instances the visible savings have far exceeded the investment. But transcending in importance the cases in which a definite financial accounting can easily be made, there is a great host of instruments that produce tremendous returns of a nature not amenable to direct computation: the latent savings of improved quality, improved supervision, and facilitated research are ultimately materialized in better products.

For those of us who rely on the analytical methods of conceptual logic as the basis for our technical judgment, the evidence that instruments save money can be regarded as sufficiently strong to warrant their increasing application.

[1] Horace Lamb, Dynamics, Cambridge University Press, 1929; also Younger & Woods, Dynamics of Airplane Structures, John Wiley, 1931.

[2] A. E. H. Love, Treatise on the Mathematical Theory of Elasticity, Cambridge University Press, 1927; also S. Timoshenko, Theory of Elasticity, McGraw Hill, 1934.

[3] See, for example, the legal unit of e.m.f., Standard Handbook for Electrical Engineers (page 123), McGraw Hill, 1922.

Key Index to American Civilization

By R. F. BOYER
Physicist, The Dow Chemical Co., Midland, Mich.

FOURTH PRIZE

IN an industrial age like our own, power consumption is a fundamental index of trends or changes, and if we are to examine the role of instrumentation in providing employment, it would be but logical to investigate its application in the production of power.

When Henry Adams[1], the American historian, was searching, toward the turn of the century, for a numerical expression of progress, he finally decided that the consumption of coal, doubling in volume every ten years, was the best available means of indicating man's increasing control over his environment. With the meager data on hand, he plotted curves which he extrapolated back to the thirteenth century as an era of minimum physical energy, but maximum spiritual energy. This was the period, as someone has so aptly expressed it, when man was power.

One can well imagine some historian of the future who likewise seeks to evaluate the progress of a later epoch. He would probably do it not in terms of energy consumption, but rather in terms of a more fundamental entity, an entity which alone permitted the increasing use of energy to continue at its tremendous rate, namely instrumentation. For if he were tempted to extend Adams' coal-consumption curves on through the twentieth century he would quickly discover the anomaly that coal consumption was actually declining after 1920 while electrical power generation was increasing rapidly, as columns 2 and 3 of Table I show. He would realize, thus, that a mere graph of coal consumption was no longer an adequate index of the energy available to man, because, aside from the use of supplementary fuels and of large scale hydroelectric developments, the power output per pound of coal had increased by as much as ten times between 1880 and 1935.[3] An inquiry into the reasons for this phenomenon would lead almost directly to the subject of measurement and control. And our historian, with much more accurate data, could extrapolate back rather precisely to the early part of the twentieth century as a period when, to follow the analogy, spiritual control, *i.e.*, direct control of energy by human effort, was a maximum, while control of energy by instruments was a minimum.

TABLE I. COMPARATIVE INDICES OF COAL PRODUCTION, INSTALLED CAPACITY OF STEAM GENERATING PLANTS, AND SALE OF INSTRUMENTS TO THE POWER INDUSTRY, FOR THE UNITED STATES

Year	Total coal production[2] 1930 = 100% = 536,910,000 short tons	Installed capacity of steam generating plants[3] 1930 = 100% = 31,000,000 h.p.	Sale of Instruments to the Power Industry[4] 1929 = 100% = approx. $1,500,000
1880	11.9	—	—
1900	19.0	3.0	—
1920	121	38	—
1923	116	51	53.4
1925	111	63	66.2
1927	107	86	86.1
1929	102	93	100.0
1930	100	100	93.4
1935	78	—	55.7

For example, in the thirty years between 1902 and 1932 the energy output of electric central stations increased by 32 times, while the number of men employed in operating these central stations increased only eight times.[3] That eight times as many men, working shorter hours, could produce thirty-two times as much energy, whose average selling price, moreover, had shown a three-fold decrease, was not a question of magic, but a simple matter of instrumentation. Indeed, columns 3 and 4 of Table I indicate how the sale of instruments to power companies has paralleled in a remarkable fashion the growth in installed capacity of steam generating plants.

The arithmetic involved here is interesting. Electric central stations in 1930 used some 43,000,000 pounds of coal.[3] With the coal efficiency of 1880, six times[7] this amount would have been required, or nearly one-half of the entire United States' production of coal for 1930. The problem of converting this tremendous tonnage of fuel to electric power would have presented almost insuperable difficulties in handling and control, in addition to making electric power from it a luxury.

It was not that instrumentation alone was directly responsible for this increased efficiency of the present time. Rather it was a combination of various factors, many of which depended in turn on the existence of instruments: better insulating materials; higher operating temperatures, which demanded improved alloy steels to withstand them, as well as more accurate control of steam purity to reduce turbine blade corrosion; precisely designed high-speed turbines and the indicating instruments to warn of overheated bearings or faulty lubrication at these higher speeds; exact combustion control through the use of CO_2 recorders; and many other similar items. Then, too, with frequency meters and remote control devices functioning ably, vast electrical networks could be interconnected to allow uninterrupted service and the most efficient use of equipment at all times. Briefly, in the words of Prof. Potter: ". . . power plant operating technique has greatly benefited by automatic and semi-automatic control, by the development of heat saving equipment in connection with the modern steam generator, and by the perfection of accurate meters and instruments."[5]

Raymond F. Boyer was born 1910 in Denver. B.S. and M.S. in Physics from Case (Cleveland) latter in 1935. As caretaker at Warner & Swasey Observatory while a student, he was introduced to high-precision instruments. With Dow Chemical since 1935, the first year in training course involving work in plant Instrument Department where he became familiar with industrial instruments; since 1936 in Physical Research Lab. under Dr. J. J. Grebe (see *Instruments*, March 1936).

In the period from 1902 to 1932, when the total output of central stations was increasing thirty-two times, the electric power used by industry itself had increased some three and one-half times, or from 12,500,000 to 42,000,000 horsepower,[3] while the number of men employed by industry jumped from 7,900,000 to 14,000,000,[3] and the average amount of horsepower available to each worker increased from 2:1 to 4.67, [3, 6] thus raising his productivity. Stated in other words, lower production costs meant wider consumption, and this in turn required more employment.

It was such considerations as these that led the British statesman, Lloyd George, to recommend in his book, "Coal and Power," published in 1932, the complete industrial rehabilitation of Great Britain, pointing out that industrial

[1] H. B. Adams, The Education of Henry Adams, 24th ed., Houghton, Mifflin Co., 1918. Pages 379 and following.

[2] *Encyclopaedia Britannica*, "U. S. of America, Mineral Products," 14th ed., Vol. 22, page 748, 1937 revision.

[3] A. A. Potter & M. M. Samuels, in Technological Trends and National Policy, U. S. Government Printing Office, June 1937, Pages 249 and following.

[4] G. Perazich & H. Schimmel, Instrumentation as a Factor in America's Changing Technology, *Instruments*, Vol. 12, Jan. 1939. Pages 3-6. Specifically, Table 7, page 5.

[5] Anon. Public Relations in Industry, "Insert" in *Electronics* Vol. 11, Oct. 1938. (Also inserted in other McGraw-Hill publications of that date.)

[6] In this connection see data on percentage of electric power used by the large industries, U. S. Census of Manufactures, 1927.

[7] This factor of six was obtained by linear interpolation between the coal efficiency figures of 1918 and 1935 and may easily be in error by 25% to 50%.

workers in America used about two and one-half times more power per person than did similar workers in England, and that the material welfare of American workers was greater in roughly the same proportion.

Here, briefly, is our thesis: In an industrial age like the present one, production and the employment that production implies depend more and more on cheap and abundant power; in fact, the existence of whole large industrial developments with the thousands of jobs they provide would be inconceivable today without electric power; and this cheap and abundant power depends, in turn, largely on the ramified improvements in technology that instruments and instrumentation have made possible. Here, our historian might conclude, was decisive proof that instrumentation can and does make jobs; that the statistics of instruments provide the key index to twentieth century civilization.

Testing Instruments, Too, Pay Dividends

FOURTH PRIZE

By WILLIAM J. CREHAN
Chemist, Baldwin Rubber Co., Pontiac, Mich.

DO instruments save money? The technical man will answer affirmatively; and probably will qualify his answer with the statement that *whenever applicable* in processing operations, instruments do save money. On the other hand, it has been my experience that non-technical executives are doubtful about the point, and it is to the latter, therefore, that this paper is addressed.

First, let us see what an instrument is. From one of Webster's Dictionary definitions, "*a device for doing work or producing an effect; tool; implement*" it appears that the subject is broad in scope and could apply to everyone's daily tasks. It is therefore fitting to limit discussion to instruments of a scientific nature as applied to some manufacturing process. As space is limited, I shall consider instruments as used in my occupation, the rubber industry.

William J. Crehan was born 1913 in Elyria, Ohio. B.Ch E., Ohio State, 1935. In 1936 joined St. Clair Rubber Co., Marysville, Mich., as control and analytical chemist; experimented with and developed new methods of control. In 1939 joined Baldwin Rubber Co. His work there has become more specialized, being entirely in the adhesive line. The cement department is new at Baldwin, so he has had the opportunity to organize a control and analytical department from the beginning.

Perhaps the rubber industry is more dependent on instruments, of a sort, than any other. There are so many variables and so few that actually can be pinned down with precision that the rubber technologist must measure several properties of his product before he can state with certainty that the product will be serviceable. Measuring simple properties such as melting point, boiling point, specific gravity, and so on, cannot suffice to produce first-class products.

For some years I have worked with rubber base adhesives for the automotive trade. This phase of the industry is dependent on instruments for process control and evaluation of finished products. Instruments used vary from crude home-made affairs to expensive machines of precision. For instance, at one time we were dependent on crude viscosimeters (glass tube and steel ball type) which are slow to manipulate and difficult to clean rapidly for repeat determinations. These viscosimeters cost us about fifty cents each to make and calibrate, but they cost considerably more in time and in rejected non-uniform merchandise. This was finally remedied by purchase of a modified Stormer viscosimeter. This instrument is extremely rapid and it permits any number of repeat determinations to be run without disturbing the sample. Its cost was approximately $100—but no more adhesives have been rejected for non-uniform viscosity, which fact has paid for the viscosimeter many times over.

At present, we have no analytical balance in our department. We have consequently been obliged to use one located in the main laboratory of the plant. Considerable time has been lost in this way and production is dependent upon our analyses. We are now contemplating purchase of an analytical balance, since the comparison of the cost of the balance against the cost of delayed production and inefficiency speaks for itself in a loud voice.

We are equipped with all the standard rubber instruments that have a bearing on the product we manufacture—the standard Scott tensile machine, compression set apparatus, hardness testers, gravitometers and many others. Some companies depend solely on the results of such standard instruments, and never leave the beaten path to devise supplementary service tests for their products. It is this field of instrumentation that pays greatest dividends. We constantly try to devise means to evaluate more accurately the service characteristics of our product. Many of the instruments resulting don't cost much; others do—but they serve the purpose of giving our product a slight preference over competitors', and in highly competitive fields, most contracts depend on just such slight improvements. I believe that this is generally true of most industries. It is this fact which is responsible for the development of instruments which later become standard pieces of equipment on the market. Instruments which mimic the forces of nature (*e.g.*, the Weather-o-meter) come into being in such a manner; beginning with home-made affairs with which someone tries to produce a better product than his competitors', thereby gaining more business. The net result in each case is that the instrument earned (which is synonymous with saved) considerable money.

I could relate at length the individual histories of many of our instruments, and their means of saving money, but the final monetary conclusions would all be the same—that such instruments are worth many times their original cost.

We don't always immediately buy instruments which we may need and which we have all been convinced will save money. We usually wait until the volume of business affected by the instrument in question becomes sufficient actually to show a saving. Just for example, suppose we found that the vapor pressure of a rubber solvent had a definite effect on the service characteristics of a cement, being sold in lots of a hundred gallons a month. We would have to install Reid vapor pressure apparatus to control our product, and in this case we would wait until the business grew into a volume item, or until need for vapor pressure control extended to other items.

We have saved money with instruments now discarded; are saving money with present instruments; and will continue to save money by introducing more instruments in the future. All industries must face the facts, if they desire to grow and become leaders in their respective fields, and the facts are that constant awareness to possibilities for instrumentation will save them processing time and put dollars into the stockholders' pockets.

Total of Instrument-made Jobs Always Exceeds Number of Displaced Workers

FOURTH PRIZE

By PHILIP ROBERT EWALD
Senior Engineering Aide, TVA Fertilizer Works, Wilson Dam, Ala.

OUR attention is being called today to the fact that ingenious automatic devices are being made to "think" and act in place of human beings. It is charged that these instruments are being installed to replace wage earners, and eventually create a grave unemployment problem. Though such charges are usually directed at automatic machinery, instruments are also blamed. To best determine if these charges are justified, let us examine the instrumentation industry step by step, and perhaps discover that it, like many others, has been responsible for creating countless new jobs.

In the first place, the manufacture of instruments obviously creates jobs that otherwise would not exist. Consider the modern American home: When furnace and oven controls, thermometers, dial telephones, and water, gas, and electric meters are multiplied by millions of installations, a sizeable industry is created. In the transportation field, 5,000,000 sets of instruments must be manufactured each year for new motor vehicles; and ships, railroads, and aircraft are all heavy users of instruments. In the consumer goods industries, a modern factory or processing plant requires an elaborate complement of indicating and control devices. In the "heavy" industries, even more so. In all scientific endeavor, whether in industry or schools, instruments are a first requirement. For the manufacture of industrial and scientific instruments alone, there are employed 5,000 salaried workers and 17,000 wage earners.

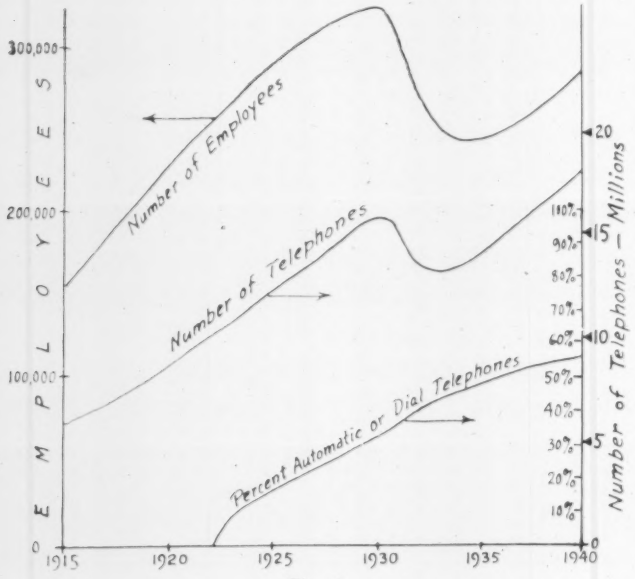

Fig. 1

But that is not all: The *use* of instruments in the above-mentioned fields is responsible for the creation of yet more jobs. Complete organizations are needed for the reading and servicing of utility meters in the home. The transportation field employs many men to read instruments and interpret the data: Navigators, ship engineers, meteorologists, etc. Each large factory employs a staff of men to install and maintain instruments and to interpret their data. Scientific work employs many instrument users, as in sound elimination, geophysical exploration, and in many forms of research work. These jobs are created directly by instruments, where instruments are a major part of everyday work.

Philip R. Ewald was born 1914 in Knoxville, Tenn. Graduated 1935 in Engineering Physics, Michigan U. After a year of electrical and drafting work he came to TVA in 1936, first learning how to install and service plant instruments; since then developing special sampling, measuring and control devices, including precision laboratory furnace controls, pH and titration apparatus. Hobbies ("useful"): amateur radio, electronics, photomicrography; ("not so useful" says he): gliding.

Indirectly, *all* jobs in our American civilization are dependent more or less on instruments. It is even safe to say that our modern civilization would not have evolved without instruments. Exploration would not have been possible without such simple instruments as the sextant and compass. Another old instrument, the clock, is responsible for coördinating our lives. A modern industry, possible only through the use of modern instruments, is the aviation industry of today. It is built around instrument-measured engines, instrument-refined gasolines, and is operated by highly developed instruments. This industry keeps doubling its employee rolls every few years.

But are any jobs eliminated? Let us review the various fields as before. In the home, instruments are used as an aid and comfort to the householder; no workers are replaced. In transportation, they are used as an aid to operation and navigation: the airplane gyropilot flies a plane better than can the human pilot, relieves the strain of long hours at the controls, but cannot replace him. For factory operation, instruments are used as measuring devices and as process controllers. These latter, the automatic controllers, may be used to eliminate some routine jobs, such as watching a dial and then turning a valve in response, but this can only be true in a large plant, where elaborate automatic-control instrumentation may be used to eliminate full-time valve-turning jobs, and we must bear in mind that a large plant requires a staff to care for the instruments, so that the final result usually is more—not fewer—jobs. In scientific work, any instrument that can be put to a routine task relieves the worker but does not eliminate him: it gives him that much more time toward advancement. (There has never been a dearth of jobs in research, only of resources!)

We have seen in a general way how instrumentation has been responsible for the creation of a limitless number of jobs at the expense of a few. It would be well to examine an industry that has employed instrumentation extensively and see what the effect has been on employment rolls. An excellent example is the Bell telephone system. This organization employs, in effect, a gigantic instrument wherein an impulse at any point in the country may be made to give an impulse at any other point. In 1915 it was entirely manually operated. Today it is over half completely automatic. This gigantic instrument has been developed to nearly as high a degree as is possible. Not only are the circuits automatic in operation; they are tested by automatic instruments! Fig 1 shows the increase in number of telephones and employees, and percentage of automatic telephones from 1915 to date. In that period the employee roll increased 68% while the manual telephones increased only 28%, hence at least a 40% rise in employment was due to automatic installations. It might seem that the 170% total increase in telephones should account for a greater employ

Start the New Year . . . WITH THE NEWEST INFORMATION ON THERMOMETERS AND FLOW METER SERVICE

With 1940 comes a new chance to take a *forward-looking* view of plant needs, and of today's equipment for meeting them. There's no better time than right now to make sure you're fully up-to-date in your knowledge of the profit possibilities of modern Thermometers and Flow Meters under 1940 conditions. And there's no better way to begin a check-up than by looking over these informative new bulletins which Foxboro has just received from the printer.

Most foresighted operating men, we know, watch "new equipment" notices right along for ideas and improvements that can bring better performance or lowered costs to their own operations. In the field of instrument service, though, every week brings new applications . . . better ways of doing things . . . possibilities for savings confirmed in actual plant experience.

That's why we say: Why not spend a few minutes in stock-taking for the New Year? Why not make sure you've got a clear-cut picture of 1940 instrument models and 1940 instrument methods? Once you've looked these bulletins over, you'll be prepared to make a sounder analysis of problems in which temperature is a factor, or in which the flow of steam, liquids or gas affects costs or product quality. Short of calling in a Foxboro specialist to advise you in attacking a specific problem, it's your best way of being fully informed on profit-building instrument performance. **The Foxboro Company, 46 Neponset Avenue, Foxboro, Mass., U. S. A.** Branch offices in 25 principal cities.

MAIL THIS COUPON FOR A 1940 CHECK-UP

The Foxboro Company
46 Neponset Avenue
Foxboro, Mass.

☐ Please send me, *by mail*, your new 40-page Bulletin 198-2, "Recording Thermometers" which, in addition to a complete review of types, specifications, ranges of 1940 Foxboro Recording Thermometers, also contains valuable installation suggestions.

☐ Please send me, *by mail*, your newly revised 48-page Bulletin 200-4, "Meters for Steam, Liquids, Gas," which I understand will give me a good picture of meter service as well as design features and specifications.

☐ Have your local Foxboro man phone me for an appointment, to discuss instrument needs.

Name.....*Position*.....

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FOXBORO
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RECORDING | CONTROLLING · INDICATING
Instruments
Certified ACCURACY RESPONSE
TEMPERATURE · LIQUID LEVEL
PRESSURE · FLOW · HUMIDITY

ment rise. A comprehensive analysis, beyond the scope of this essay, would show how the greater number of telephones was possible only through improved organization and reduced customer costs. The main fact is that a 40% increase in permanent employment in the largest single organization in the U. S. has resulted from the installation of a nation-wide automatic instrument.

To be sure, instrumentation has in many cases been employed to *eliminate types of jobs*. These vanishing occupations always were of the routine type, requiring little thinking and mostly reaction. They paid little. In their place, instrumentation has always created jobs requiring intelligence and technical skill, with higher pay. It has not only replaced these old jobs so that men have not been thrown out of work, but it has created boundless others and opened vast new fields for still more employment.

Eight Ways of Saving Energy

FOURTH PRIZE

By RALPH RAND

Casper Works, The Texas Co., Casper, Wyoming

Born in North Dakota, Ralph Rand went to N.D.U. and, while studying, obtained Class A amateur radio license and was part-time operator of Station KFJM. After graduating in 1936 (B.S. in E.E.) he went to Philadelphia to repair radios for Philco. He studied instrumentation in the Brown Instrument Co.'s Training School and its Service Division; gained further instrument experience with the Nat'l Can Co., Maspeth, N. Y. For the Texas Co. his work is in oil refinery instrumentation.

DO you read your instruments' story, the story of what happens on your plant units every minute of the day? Why grope in the dark when you have a daily news service with news flashes the minute they occur and 24-hour-a-day coverage! What's happening that a certain unit is not coming up the way it should? Consult your chart files and find the complete story of what happened under similar circumstances. You can't get a better service than buying essential instruments: a service that will pay for itself more quickly than do most classes of plant equipment.

What can instruments do for you? Have you considered their use to meet today's keen competition, to control your costs, to maintain your production schedules, and to obtain better and higher yields through smoother operation and decreased waste? Or their use in obtaining a correct accounting of labor and material and determining the efficiencies of man and machines.

How can you enjoy these rewards in your plant? You can by intelligently interpreting the readings of your instruments. First of all, an instrument guides the operator and gives the supervisor a quick check on operations. However, these same readings can bring about savings in power and, yes, savings from decreased emergency situations. Equally important are uniform quality, steady rate of output, avoidance of breakdown, and good will.

Are you considering the savings from reduced energy consumption? The study of most processes involves heat balances and energy flow. Economic operation depends on the efficient utilization of the heat and electrical units. Trace the path of your power dollar and save.

The keeping of heat processes within set limits is vital to maintenance of expected costs for labor, material, heat and power; to long life of capital equipment and to the maintenance of standard product quality. If the critical temperature is not reached and sustained, the desired action does not take place. Too high furnace temperatures in some sections shows that secondary combustion is taking place, burner pressure is too high, baffles are broken and heat is not being absorbed. Furthermore, constant heater outlet temperature insures balanced flow and constant load on the heater, decreased coke formation, increased yield, and maximum stability on the whole unit. Temperature readings on the heat recovery units determines their efficiency and condition and whether they are justified, for their use may decrease the efficiency of another unit in the process. A change in the operating characteristics of one unit of a process may change the operating characteristics of succeeding units and cause a waste of energy consumed.

Pressure readings insure safety and help analyze energy consumption. Pressure and temperature work together in determining the phase of a substance and how much energy is necessary to convert that substance to a different phase. Excessive processing pressure may mean clogging of units through coke or scale formation. Uniform steam pressure increases engine-room efficiency and raises the quality of the processed product.

In dealing with all energy losses bear in mind that a meter which records the quantity of power used in each department determines the power requirements and when they occur; and permits cost accounting. Losses of energy can be traced but primarily these instruments are used to schedule the work of a department so as to keep the power requirements uniform. Power can be regulated manually or automatically by cutting off part of the load when necessary to keep within the demand requirements.

A unit loaded to its rated capacity is operated at its highest efficiency. Just as flowmeters may determine the efficiencies of some equipment by measuring the input and output flows and bring about smooth operation by keeping the load constant, so will ammeters and wattmeters determine the point of highest efficiency of electrical apparatus. Instruments on machines often cure trouble of a human nature. Mechanical wear and increased friction may be the cause of overloads. Experiment with your lubrication and measure the power consumed, for the correct lubricant may make possible a reduced size of motor and a saving in energy. Instruments will show the size and nature of the loads. However, speeding or slowing down the process may also be a solution.

Voltmeters insure that your equipment is operating at the voltage for which it is designed. The cost of light is an economic balance between cost of current and cost of bulbs. Low-voltage may increase the life of a bulb, but it actually increases the cost per lumen in comparison with the cost at rated voltage. Energy consumption, as far as lighting is concerned, deals with proper intensity of illumination where needed and the laying out of a lighting system so that only essential lights can be used at the proper time. Don't guess—use instruments.

Electrical power transmission brings in copper loss. An ammeter will help balance your load and determine whether the conductors are large enough. Better, use high voltage for transmission and at the load step down to the proper voltage to keep the distance of low-voltage transmission small. Electrical consumption also depends on power factor readings. Lightly loaded induction motors and transformers with high exciting current waste energy.

The amount of savings instruments can bring you depends on your ingenuity in interpreting their readings. Use only essential instruments, for overinstrumentation promotes overconfidence and a leaning on instruments to do all the work. Look behind their news, for there the possible savings become apparent.

Complete Control RETURNS 122% AT *Sucrest Refinery . . .*

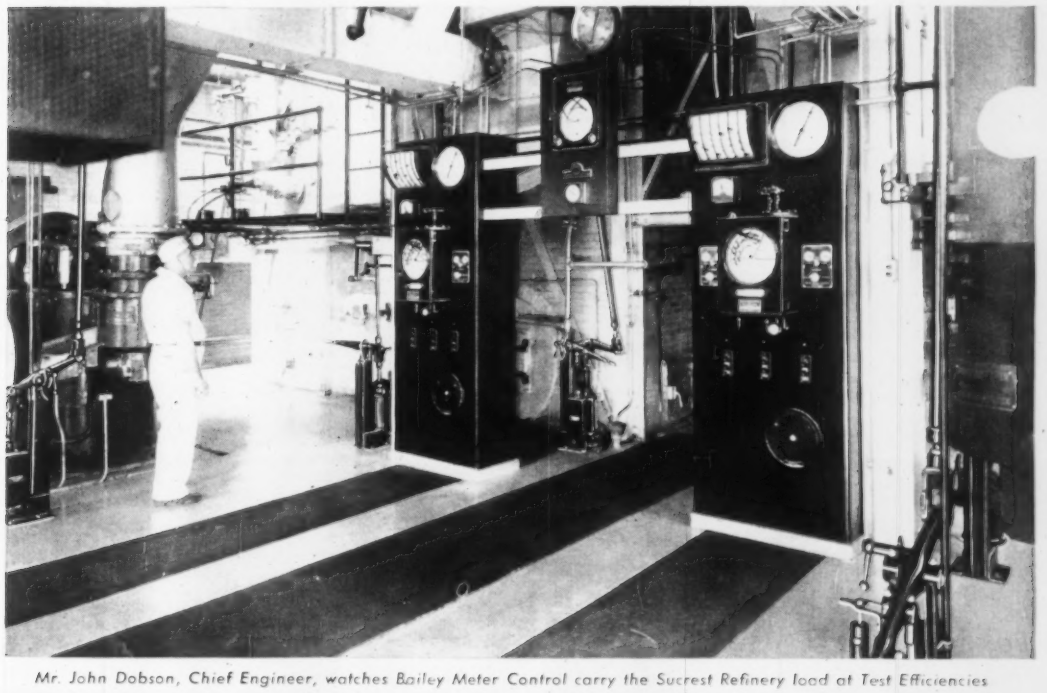
FULL AUTOMATIC OPERATION BY *Bailey Meter Control* SAVES $4,960.00

Actual results obtained by the application of Bailey Meter Control to two 35,000 lb. per hour capacity, 250 lb. pressure pulverized coal fired boilers are evident from the following statements made by Mr. Frank C. Staples, Plant Manager at the Sucrest Sugar Refinery, Brooklyn, N. Y.

From March, 1936 through December, 1936, boilers were operated manually in accordance with meter readings. Beginning in January, 1937, boilers were automatically operated at test efficiencies by Bailey Meter Control. During the year 1937, this installation of automatic control produced fuel savings of $4,960 which alone amounted to 122% of the cost of the control.

The installation of COMPLETE combustion control on the boilers in your power plant is one of the few "High Return" investments open to your company today. Send for your copy of the new Bulletin 102-B describing Bailey Meter Control

BAILEY METER COMPANY
1041 IVANHOE ROAD A-431 **CLEVELAND, OHIO**
Bailey Meter Company Limited, Montreal, Canada



Mr. John Dobson, Chief Engineer, watches Bailey Meter Control carry the Sucrest Refinery load at Test Efficiencies

BAILEY METER CONTROL

The Complete Combustion Control System

Boiler Meters • Multi-Pointer Gages • Fluid Meters • Recorders • Superheat Control • Desuperheat Control • Combustion Control • Feed Water Control

Modern Instruments Cut Leak Detection Costs

FIFTH PRIZE

By FRED A. GURDES

Municipal Engineer, Oak Park, Illinois

IN recent years the locating of water leaks has become an important factor towards operating a water plant at high efficiency. In many cases the sound of water leaks is difficult to find when water will seep a long distance before it shows up on the surface. The writer has had two difficult water leaks to locate—difficulties being due to the expensive superstructure over the water mains. The method used was new: measuring sound through selective amplification of the water leak noise, rather than by listening.

Since leaking water causes friction, naturally it gives off a sound. The object is to measure this characteristic sound by selection and amplification. The sound is picked up by a sensitive microphone which is connected to a water hydrant, faucet or water valve stem. The instrument also has a frequency selector which tunes in the number of vibrations the sound is producing. There is also an amplitude meter which determines the distance the leak is from the point of test.

By observing the readings at each test point the maximum reading will locate the water leak within excavating range of the leak.

One water leak was under a heavy concrete floor. After several guesses were made using the old method, several needless excavations were made; then the new apparatus was used and with careful checking and reading of instruments the water leak was definitely located and promptly repaired. Later it was found that approximately 6,000 gallons per day had been lost through this leak.

Fred A. Gurdes, born Chicago 1890, trained at Lewis Institute there. From 1906 to 1913, in substation dep't and generating plants of Commonwealth Edison. Then assistant to Electrical Engineer in Charge for Commissioners of Lincoln Park. Two years in U. S. Army Air Corps as Observer. In 1921 opened an office on LaSalle St. as Consulting Engineer on Public Improvements. During past five years, has supervised installation and operation of many types of instruments, including heat control in steel industry; electrolysis investigations; sound measurements; cable fault finding; and locating sneak grounds on interlocking railroad signal systems.

Another case was where a water leak was found at the house service which was connected to an 8" cast iron water main in the street. Several tests were made by the old method of hearing the sound, but the leak could not be found, even after several excavations. Using the sound measuring instrument method the leak was located 2 feet back of the buffalo box on a ¾" lead service. It had been leaking at the rate of 3000 gallons per day.

The time required to locate the first leak was 3½ hours and the second leak was 2 hours.

This type of instrument takes the guess-work out of water leak detection. It effects obvious savings particularly over paved roads and sidewalks where expensive replacement is an important cost item. Only one excavation is necessary to locate and repair the water leak and reclose the excavation.

Costly Troubles Due to Impurities in Distilled Water Ended by Modern Instrumentation

FIFTH PRIZE

By M. KEVELSON

Engineer, Solar Mfg. Corp., Bayonne, N. J.

ONE of the most important developments that have made possible the modern midget radio set is the electrolytic condenser. Before its advent paper condenser assemblies were used—almost as large as the present midget set itself. The electrolytic condenser is hardly noticeable. By virtue of its adaptability to the radio set, and because of its low cost, its manufacture has become a $10,000,000 industry in the last ten years.

One of the practical problems that had to be solved before ending the excessive amount of spoilage that occurred in production, was the control of the quality of distilled water that entered into the manufacturing process.

The principle upon which the electrolytic condenser operates depends upon a peculiar property of aluminum which allows a microscopically thin dielectric film to be formed on its surface. This film, when immersed in an aqueous medium, acts as an electrical condenser. Its function in the radio set is to smooth out the pulsations of the rectified alternating voltage for the plates of the vacuum tubes.

The electrolytic condenser, as it is made today, consists of two aluminum foils separated by an impregnated paper spacer and rolled into a small cylinder. The material used to impregnate the paper spacer is an aqueous paste of creamy consistency which contains ammonia, boric acid, and ethylene glycol. This paste is usually referred to as the "electrolyte."

By electrochemical means, one of the foils has the dielectric film formed on its surface. The nature of this film is such that the presence of the least impurity in the forming

Born New York City 1899, Mr. Kevelson studied mining engineering at Cornell 1916-21 with wartime interlude (U. S. Navy 1918). Grad. from Cornell as M.E. in 1921. Later studied chem. eng. at Brooklyn Poly (grad. 1931). However, having been a radio amateur from boyhood, has mostly worked with radio and electrical mfrs. since 1921. Chief Engr. Condenser Corp. of America 1928-32. Later, engaged in development of devices for continuous measurement and control of paper. His work for Solar since 1936 has mainly been to develop processes and control methods for electrolytic condensers.

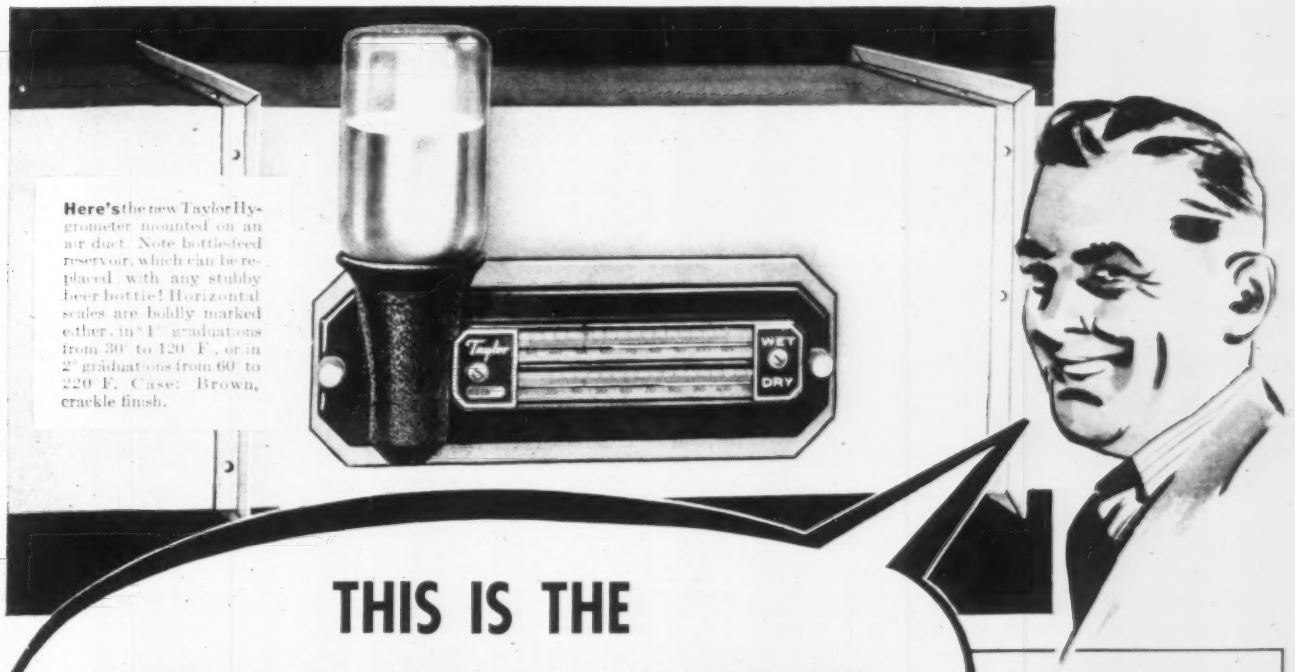
solution will either greatly lengthen the time of formation or prevent it entirely. In addition, any impurity in the paste will cause the film to deteriorate rapidly and lose its dielectric properties.

The most deleterious impurities are chlorides: as little as one or two parts per million in the forming solution or the paste is seriously detrimental. Five parts per million is fatal. Other impurities, such as sulphates and nitrates are also detrimental, but to a lesser degree.

Fig. 1 shows how the chloride content affects the time required for the formation of the dielectric film. It is clear from this curve that the period of formation increases enormously with any slight addition of chlorides.

Not only is it necessary that all chemicals used be free from chlorides, but it is extremely important that nothing but distilled water be used throughout.

Distilled water enters into every phase of the manufacture of electrolytic condensers. All chemicals used are dissolved in distilled water. All final washing operations take



Here's the new Taylor Hygrometer mounted on an air duct. Note bottle-feed reservoir, which can be replaced with any stubby beer bottle! Horizontal scales are boldly marked either in 1° graduations from 30° to 120° F., or in 2° graduations from 60° to 220° F. Case: Brown, crackle finish.

THIS IS THE EASIEST-TO-READ HYGROMETER I'VE EVER SEEN!

New Taylor Hygrometer for air ducts, dryers and other closed compartments constantly indicates temperature, humidity.

ALREADY plant men are saying this new, highly accurate yet rugged Taylor temperature and humidity indicator is in a class by itself. It's easier to read, install, and maintain than ordinary types. And here's why:

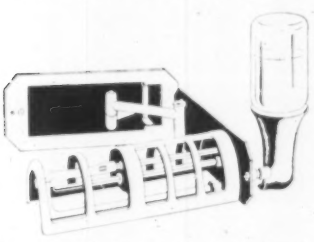
Easier to read. In its unique tube design, Taylor engineers combined the accuracy and speed-of-response of the etched-stem thermometer with the rugged dependability of the industrial thermometer. The black numerals and graduations are etched on the back of the extra-broad and flat scale, and are lacquered over in orange-yellow for maximum, *permanent* reading ease. Horizontal scale is easier to read, is enclosed in clear, easily cleaned glass.

Easier to install. The required duct opening is only 8" x 2¾". Because the mounting sub-plate is readily detached, it can be installed without danger of breaking the instrument.

Easier to maintain. All parts instantly accessible. Water supplied to wet bulb by inverting water bottle. One filling a week enough. *If this bottle ever needs replacing, just use any stubby beer bottle!*

If air pressure or vacuum exceeds ½" of water, or if you prefer an automatically controlled water supply, use the Constant-Level Reservoir. This is also easily mounted, cleaned. All parts corrosion-resistant, and sturdily made.

Read at right the features of this important-to-you Taylor Hygrometer. For further details, see a Taylor representative, or write Taylor Instrument Companies, Rochester, N. Y. Plant also in Toronto, Canada. Manufacturers in Great Britain: Short & Mason, Ltd., London.



Swings out easily for instant access. Simply unscrew two thumb screws! Wet and dry thermometers are quickly interchangeable. Note also cast aluminum construction throughout. Skeleton-like guard allows free air circulation across both bulbs. No bulb-conduction error.

Advantages you'll get with this new Taylor Hygrometer!

- ▶ New tube design increases ease of reading.
- ▶ Etched-stem-thermometer rate of response and accuracy with industrial thermometer ruggedness.
- ▶ No separate scales to slip, corrode, tarnish.
- ▶ Scales enclosed in glass for easy cleaning. Scales mounted horizontally for easier readings.
- ▶ Instantly accessible for maintenance—unit swings out from mounting.
- ▶ Bottle-feed reservoir replaceable with any stubby beer bottle.
- ▶ New skeleton-type guard allows free circulation of air across both bulbs.
- ▶ Rubber grommets thermally insulate the glass stems, minimizing conduction error, reducing breakage danger.
- ▶ Simplified installation—only one small duct opening needed.
- ▶ Available with bottle feed or constant level water supply to operate under water pressure or vacuum.
- ▶ Wet and dry bulbs staggered for efficient use in horizontal *or* vertical ducts.

Taylor

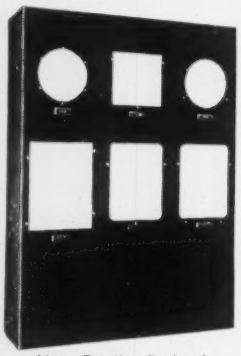
Indicating / Recording Controlling

TEMPERATURE, PRESSURE, FLOW *and* **LEVEL INSTRUMENTS**

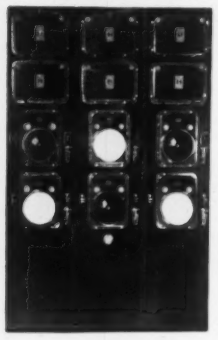
STEEL PANELS - CUBICLES - CASINGS

BUILT BY

FALSTROM



Above—Totally Enclosed Falstrom Cubicle Panel for Petroleum Refinery.



Below—Board of 3 Falstrom Standard Panel Sections. Note High Loading Capacity.

★ IMPRESSIVE APPEARANCE
Rich 5 Coat Dull Sheen Black

★ QUALITY CONSTRUCTION
Precision Designed and Built

★ COMPLETELY CUT OUT
Ready for Instruments

★ STANDARD SIZES
for Lower Cost to you

Send Blueprints for Quotations
Write for Catalog and Bulletins PI and PJ

FALSTROM COMPANY
of PASSAIC, N. J.
Steel · Fabricators · Since · 1870

place in distilled water. All tools and jigs are cleaned i distilled water. The operators wear rubber gloves that a washed in distilled water. Up to recently, the industr operated on the theory that the best-made stills continuous

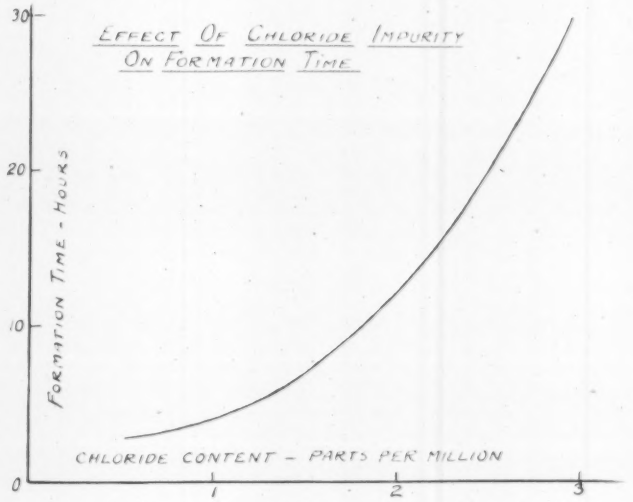


Fig. 1

supplied a high-grade distillate. Analyses revealed that fre quently this was not true: many factors beyond the contro of the still manufacturer affected the operation of the still.

Occasional priming in the evaporator was the cause of carry-over of impurities. Some reasons for this priming were: (1) change in supply water pressure; (2) change in steam pressure; (3) presence of oil in the supply water; (4) failure of steam trap to operate properly; (5) varia tion in back pressure on steam return line.

Routine checks on the distilled water were impractical, since the water was consumed almost as soon as produced. Some form of continuous control was obviously needed.

To meet this need an automatic distilled water checker was developed. This is a comparatively simple and inexpen sive device, operating on the principle that a trace of im purity in distilled water will greatly change its specific resistance. (For example, 1 p.p.m. NaCl will cause a drop from 500,000 to 300,000 ohms.)

The distilled water checker consists (see Fig. 2) of a conductivity cell, a current converter, an indicating instru ment which shows at all times the purity of the water, an alarm bell which warns the operator that the still has gone out of order, and a system of relays which operates a mag netic valve that runs impure distillate to drain. Contamin

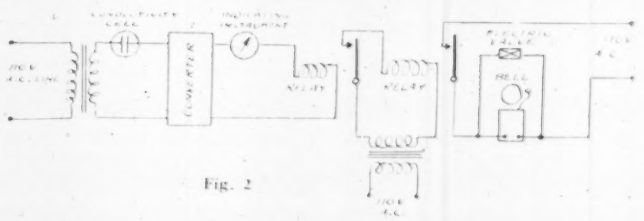


Fig. 2

ated water is thus kept from entering the distilled wate tanks. As soon as the source of trouble has been corrected the magnetic drain valve automatically closes, again allow ing pure distilled water to be fed to the tanks.

Six stills are in operation at the plant of a condense manufacturer.[1] Each one of these is equipped with a dis tilled water checker.

It has been found that the water supplied by each still i below par on an average of once a week. Before the installa

[1]Solar Mfg. Co., Bayonne, N. J.

tion of the water checkers a tank load of 500 condenser anodes was damaged each time a still went out of adjustment. This represented a loss of $44.66. Since only half of these damaged units could be reclaimed, there was a total annual loss of over $5000.

The distilled water checkers, however, have done more than save $5000 a year:

They made possible a product of higher quality, the value of which improvement and resulting customer good will cannot be measured in dollars and cents.

They enabled men who formerly spent much time making routine checks and "shooting trouble" on defective condensers to do more effective work in improving plant operations.

They proved that the control of distilled water is a paying proposition.

They brought about a realization that there were other phases of the manufacturing process to which instrumentation could be applied.

Instrumentation Made Nine Full-time Jobs in One Department; Many Others

FIFTH PRIZE

By F. F. McCLURE

Fuel Dep't, Riverside Works, Otis Steel Co., Cleveland, Ohio

F. F. McClure, born 1911 Elyria, Ohio, graduated as engineer from Reasselier Poly, 1934; then metallurgy at Case School. Inspector and later assistant roller on merchant mill of Republic Steel's Elyria Wor'ks. Next served as recorder on plate mills and checker in blooming mill of Otis Steel. At present, gas mixing station operator in the Otis Fuel Department and has also operated the annealing furnace for heavy castings. His experience with instruments has come through "direct contact with modern automatic heating furnaces, gas control, and measuring devices of the latest types." He is a member of Ass'n of Iron & Steel Engineers.

EMPLOYMENT being one of the national topics of discussion today, it is natural that the instrumentation of an industrial process should be considered in view of its effect on the employment record of a plant. In the steel industry, instrumentation is being employed widely and has tended to increase employment rather than decrease it.

A good example of this is the increased employment in the Fuel Department of the Otis Steel Co. since it has installed some new instrumentally-controlled equipment.

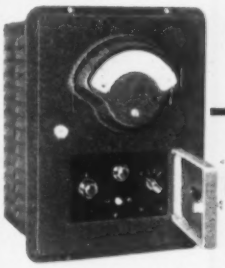
A little over a year ago Otis began the construction of a gas mixing station to mix refinery gas and air as a fuel to replace more costly natural gas on some of the mill furnaces. The actual building of the station provided work for the mechanical and electrical crews of Otis at a time when the mills were down because of the 1938 business recession and the men were not working steady.

Upon completion, operators were required and four men who had been laid off from other departments were called back and broken in to the job. The pay of the operating job was higher than the base pay of the mill and to some of the men this meant an increase in earnings, not only on an hourly basis but in the number of hours since it shuts down only on prolonged mill shut-downs. At the natural gas company no men were laid off, since Otis still uses some natural gas, while at the refinery the work of the instrument department was slightly increased. The service department of the instrument manufacturer has had its work increased to the extent that Otis has contracted for a periodical check-up (every four months) that requires the work of a service man for three days.

(Continued on page 20)

Beckman pH CONTROL

FOR EVERY APPLICATION



BECKMAN AUTOMATIC pH INDICATOR

This instrument not only gives a *continuous visual indication* of pH on a large, easily-read dial, but also provides, if desired, a *permanent written record* and *completely automatic pH control*. ANY standard potentiometric recorder or controller may be used.

This is the most advanced pH instrument available today. With it, pH control can be maintained *completely automatically* within narrow or wide limits to meet your requirements.

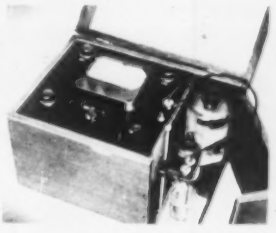
The Beckman Shielded Glass Electrodes

Automatic Temperature Compensation

Full Alternating Current Operation

There are many important features incorporated in this outstanding pH instrument. Write for Bulletin 16 which gives complete details!

THE BECKMAN INDUSTRIAL pH METER



THE BECKMAN LABORATORY pH METER

NEW! Newly developed Beckman High Temperature Glass Electrodes permit constant pH readings at temperatures to 212° F. Write for information.

World's Largest Manufacturer of Glass Electrode pH Equipment

NATIONAL TECHNICAL Laboratories

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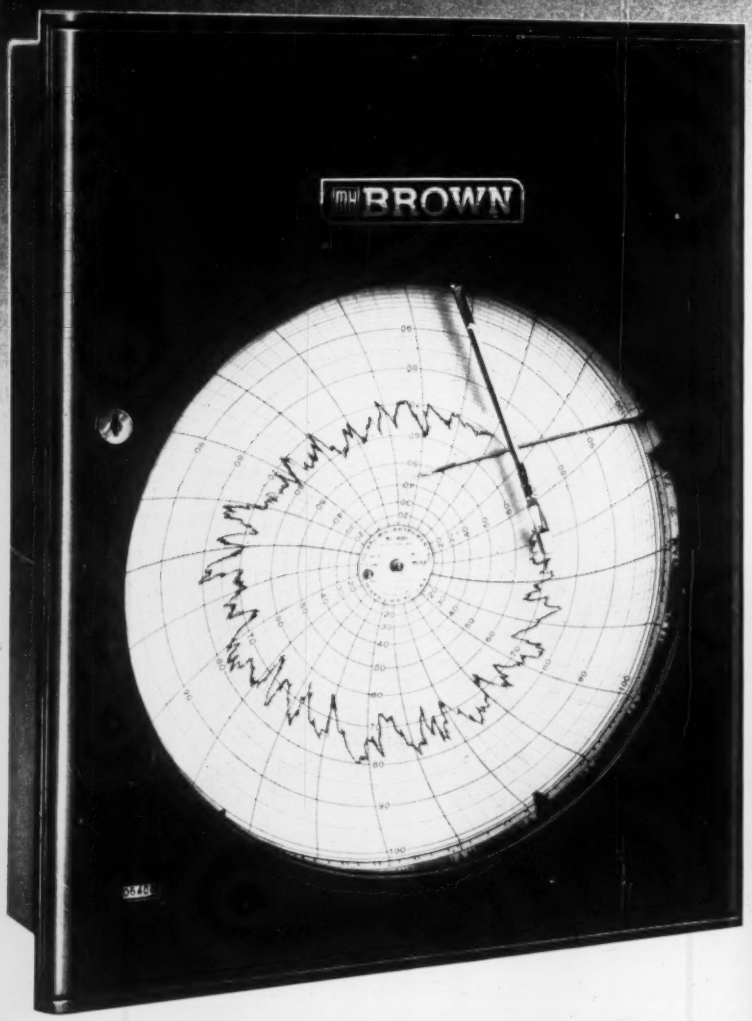
BROWN *Announce*



RECORDING, INTEGRATING FLOW METER

Modern
RECTANGULAR CASE

Styled by HENRY DREYFUSS
Designer of the "Twentieth Century Limited"

BROWN ENGINEERS COLLABORATING WITH THIS WELL-KNOWN DESIGNER HAVE PRODUCED AN INSTRUMENT THAT IS NOT ONLY A THING OF BEAUTY, BUT A TRIUMPH OF ACCURACY AND SIMPLICITY.

INDICATING FLOW METER

Advanced Design

ASSURES ACCURATE MEASUREMENT WITH SIMPLICITY FOR METERING FLOW AND LIQUID LEVELS

A NEW LINE OF FLOW METERS

With justifiable pride the Brown Instrument Company presents the latest development in Flow and Liquid Level Recorders, Indicators and Controllers.

These new Flow and Liquid Level Instruments are entirely new inside as well as out. Advanced design of the operating mechanisms provides a new conception of *accurate measurement with simplicity*—the result of years of research and field testing under actual working conditions by Brown Engineers.

The classic, simple lines of the modern streamlined case—styled by Henry Dreyfuss, designer of the "Twentieth Century Limited"—give added beauty and distinction to practical and serviceable instruments.

For modern panel mounting they blend with the panel surface and surrounding instruments to provide the much-wanted flush appearance.

Available with electrical and mechanical meter bodies for the measurement and control of steam, air, oil, gas and other fluids.

Advanced Design Embodies

NEW ELECTRIC FLOW METER: Operates on the Inductance Bridge Principle; inherently independent of voltage fluctuations.

AUTOMATIC PLANIMETER PEN: Gives a record on total flows over any period of time.

SIX INTERRELATED RANGE TUBES: With corresponding charts and scales make range changing easy, inexpensive.

INTERNAL MECHANISM: All moving parts have been designed to reduce wear and lost motion.

NEW INTEGRATOR: Insures highly accurate totalizing at all rates of flow from 0 to 100%.

DIAL INDICATOR: A 12" dial and new pointer provides better readability.

SIMPLE FLOAT MECHANISM of Mechanical Flow Meter: Insures unhampered float movement and long trouble-free operation. Single lever connects float to pressure-tight bearing shaft. No chains or complicated linkage to impede float movement or get out of order.

LARGE FLOAT: Provides ample power to accurately transmit to the pen minute variations in mercury level, thus assuring accurate measurement.

PRESSURE-TIGHT BEARING—Precision Made: Eliminates the necessity for a stuffing box. The bearing is packed with grease especially suited to the service and operating pressure for which the meter will be used. Automatic, built-in lubricator insures constant lubrication of the bearing under all conditions.

PRESSURE CHAMBERS: Designed to withstand the severe service demanded from this type of meter. High pressure chambers on all meters are forged steel. Sturdiness is built into every part to insure long, trouble-free service.

MODERN RECTANGULAR CASE: Of die-cast aluminum, dust and moisture-proof and resistant to moist salt and acid atmospheres. Includes such desirable features as dust shield, concealed hinges with exceptionally heavy pins, door stop, oil resistant recessed gasket, and cam action handle-lock which draws the gasket firmly against the case.

UNIVERSAL MOUNTING: Universal case permits mounting flush on panel with concealed clamps or on floor stand, wall bracket or pipe saddle.

IMPROVED RECORDING SYSTEM: Linkage is reduced to a minimum. Outboard bearing and hardened pivots on pen shaft insure unhampered pen movement and instant response. Stainless steel pen arm is 8" long, with ribbed reinforcement, permits pen travel of 4½". Pen and pen arm are non-corroding, easily removed, cleaned and replaced with no effect on calibration. Micrometer adjustment on pen arm assures precision setting.

SIMPLE CHART DRIVE: New chart hub eliminates chart slippage, screw knob and chain—chart is placed on over two tapered studs. Chart hub acts as a time setting device and friction clutch facilitates setting chart for correct time.

RESILIENT MOUNTING: A rigid, flat sub-plate with 3-point resilient suspension mounting carries all moving parts. Insures permanent alignment.

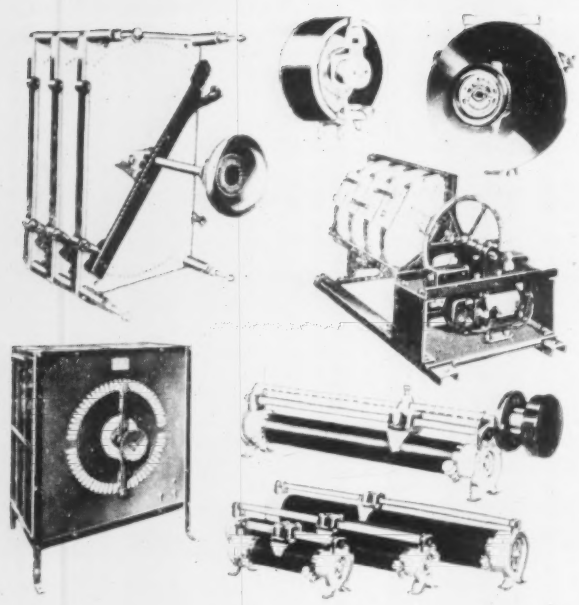
ELECTRIC AND MECHANICAL METER BODIES: Are available in various models. Each meter body is tested at double its rated working range up to 5000 lbs. pressure.

The above-mentioned features are but a few of the many new developments found in the New Brown Electric and Mechanical Flow Meters

For full details write THE BROWN INSTRUMENT COMPANY, a division of Minneapolis-Honeywell Regulator Co., 4482 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter Street . . . Amsterdam-C, Holland: Wijdesteeg 4 . . . England: Wadsworth Road, Perivale, Greenford, Middlesex . . . Stockholm, 16, Sweden: Nybrokajen 7.

BROWN Flow Meters

Accurate Measurement with Simplicity



A RHEOSTAT LINE THAT IS COMPLETE

The bulletins describing the various Ward Leonard Rheostats are probably the most complete compilation of Rheostat data ever assembled by a single manufacturer. They cover a range from the tiny types for fractional horsepower for motors to the mighty multiple units that control the rolling of steel. The subjects of manual and motor drives, mountings and accessories are likewise completely covered. Ward Leonard is a quality line. Each item represents the "latest" in the field. Make your selection from the Ward Leonard data bulletins and be assured of a successful installation.

WARD LEONARD

ELECTRIC CONTROL DEVICES SINCE 1892

WARD LEONARD ELECTRIC CO.
38 South Street, Mount Vernon, N. Y.

Please send me complete set of your latest Rheostat Bulletins

Name.....

Firm.....

Address.....

City..... *State*.....

Over in the annealing department a while ago Otis installed some de-oxidizing units in order to improve the ga for annealing of strip and sheet steel. Beside the work of installing these, three men were given jobs as operators.

Then two new automatic soaking pits were built: mor jobs due to automaticity.

With the addition of all this equipment, the work of the fuel office force was increased to the extent that the fue distributor was given a helper. Then the meter repair man receiving an increased number of calls, was also given a helper. To fill these two positions the company recalled two men who had formerly worked on the hand mills of the sheet department. This gave jobs to two men thrown out by the retiring of obsolete rolling equipment. In the metallurgy department a man is kept busy most of the time taking care of their instruments.

So it can be seen that due directly to instrumentation in the last couple of years *nine new full-time jobs* have been created in the fuel department alone, and a number of part-time ones in other departments and companies. The relatively steady employment which these jobs have provided has helped Otis in that it works to keep the unemployment compensation applications of the men down towards a minimum. This is important here in Ohio because a company which lowers the number of its men's compensation applications receives a lower compensation tax rate from the state as a reward for maintaining employment.

Jobs provided by instrumentation do not have the strict physical requirements that many of the old steel mill jobs used to have; and are really a benefit to the men and their families. In the modern steel plant the old-time hot heavy work is fast disappearing and machines and instruments are taking their place, which means more pleasant and healthful work for the men. Iron and Steel Institute figures show that in 1937 employment in the steel industry reached an all-time high. It probably will make new highs in 1939.

So when one considers that instrumentation provides work such as it has at Otis Steel Co., beside maintaining an industry to produce the instruments, it can readily be seen that instrumentation does make jobs.

Photoelectric Relays Save $21,000 In Seven Years

A MANUFACTURER of automobile parts seven years ago installed, on a transfer press, photoelectric equipment which paid for itself in the first day of operation. Previous to the installation the manufacturer experienced periodic trouble on his six-operation-sequence press. A part would stick on the ram, the feeding mechanism would automaticaliy place another piece under the same ram, and when the ram came down on the two pieces the expensive die would be damaged.

To prevent this damage, six General Electric photoelectric relays were installed to watch the operation and to stop the press before the second operation, should any part stick on the ram. The contacts of the six relays were connected in series so that the establishing of a light beam between any of the light sources and its corresponding phototube acted to de-energize a solenoid and trip the clutch of the press. As a further protection the light sources were also series-connected so that a failure in the light would bring the machine to rest. A push-button is so located that the operator can stop the machine at will.

During the first day of operation the photoelectric relays stopped the press when a part stuck on the ram. The cus-

EDITOR'S NOTE—This item was not entered in the Contest: It was released on Dec. 21 by the G-E News Bureau. As a rule we do not print press releases, insisting on articles especially written for our readers. However, this one fits in perfectly among the prize-winning essays and—a distinction never before enjoyed by any other Instruments *article—is printed exactly as written.*

tomer stated that the price of the protective equipment was about one-half what it had cost on previous occasions to repair the die. In other words, the equipment more than paid for itself the first day.

The photoelectric relay equipment has been running successfully for more than seven years and it is estimated that it has saved the manufacturer $3000 a year in maintenance or a total saving of $21,000 to date.

Leased Instruments ($16,000 a Year) Saved More, Trial Proved

FIFTH PRIZE

By H. OLKEN

Junior Electrical Engineer, Navy Dep't, Washington, D. C.

A graduate of the Radio Engineering Course at Harvard (A.B. 1929; M.A. 1930) Mr. Olken has since 1930 applied this knowledge to the invention and development of instruments and automatic control devices, chiefly with Atlantic Precision Instrument Co., Mason-Neilan Regulator Co. and (since 1937) in U. S. Gov't service. Not continuously, however, for in 1931-32 he was engineering editor of *Instruments*. His inventions, before and since this interlude, include telemetering systems, electronic type measuring and controlling instruments, a new "transformer balance" principle and an improved method of measuring moisture content.

WHEN we wear rubbers over our shoes in the rain we little realize the interesting and important role instrumentation has played in the mass production process of making them.

The process of making rubbers is as follows: you wrap the cloth, which forms the lining of the rubber, cut to form, on a wooden last. On the sole you stick a thick sheet of pasty, uncured rubber stamped to the desired shape and the desired sole design. Then from a thin sheet of uncured rubber is cut out a single piece, shaped to form the entire upper. This is pasted in place over the cloth on the last. The last and covering are then placed in a vulcanizer and vulcanized; and come out as the finished rubber.

Average thickness of the plastic rubber sheet, from which the upper is made, is only 13 thousandths of an inch. And it must not be more than 0.003" too thick or too thin. For if too thick, the rubber does not paste well on the cloth lining; besides, too much rubber is consumed. If too thin by over 0.003" the rubbers do not stand up well.

To gage the thickness of this soft, pasty sheet, only 0.013" thick, is a problem. The contactor of a dial gage or micrometer sinks into it, giving readings indefinite, unreliable, and unrepeatable. Besides, the sheet is turned out at high speed, hence gaging must be instantaneous and continuous.

An instrument company developed a non-contacting gage. In it the rubber sheet is passed between two plates of a radio condenser. Change in thickness of the sheet causes change in capacity of the condenser. Such change is read continuously on a scale calibrated directly in thousandths of an inch thickness of the rubber sheet. A sensitivity of one inch of scale deflection per thousandth inch of thickness of the rubber sheet is usual. The operator of the calender rolling out this sheet can thus control it to the exact thickness required—usually to a split thousandth.

There were in 1931 eight of these gaging machines in the Boston plant of a rubber company. They had been leased to the company by the instrument company at an estimated one-tenth of the first annual saving, set at $2,000 apiece. With the mounting business depression at that time and drastic decline of business, it seemed desirable to cut out these machines and thereby "prune" the operating expenditures by a goodly sum—$16,000 annually.

To test the feasibility of this, a run was made to see how

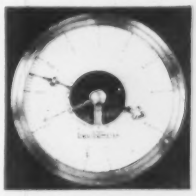
LIQUID

A$$ET$

Controlled

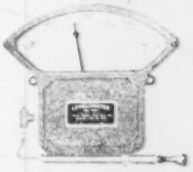
LIQUIDOMETERS provide continuous dependable and accurate knowledge of liquid levels.

LIQUIDOMETER
REMOTE READING GAGES



Automatically indicate or record liquid levels. No pumps, valves or auxiliary units required to read them. Balanced hydraulic transmission system ingeniously compensated for temperature variations on communicating tubing. Accuracy unaffected by variations in specific gravity. Approved by Underwriters Laboratories and similar bodies for gauging hazardous liquids. Models are available for remote signals, automatic control of pumps, etc. DIRECT READING models available where remote reading is not required

LEVELOMETER
Dial Type Hydrostatic Gauges



Operate on hydrostatic principle of establishing balance between head of liquid and an indicator. Dial indication featured. No liquid to expand or contract and create errors. One dial can be arranged to gauge a group of tanks.

LIQUIDOMETER
THERMOMETER

Completely free from inaccuracies due to temperature variation at indicator or along transmission tubing.

"Liquids worth storing are worth measuring"

Write for details.

THE LIQUIDOMETER CORP.
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EPPLEY STANDARD CELL
A precision Standard of Electromotive Force

The low temperature coefficient form of the International Standard of Electromotive Force

Cat. No. 100. Standard Cell, cadmium, unsaturated, for use in precision measurements of electromotive force. Guaranteed to be within 0.01% of certified value. Negligible temperature coefficient. Internal resistance not over 500 ohms. Mounted in black bakelite case.

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"To Err Is Human!"
Pope
Avoid Human Error
in your
PRECISION TIMING
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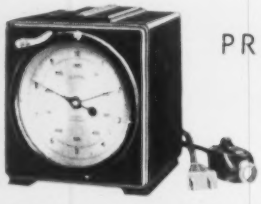

STANDARD ELECTRIC
STOP CLOCKS

You *know* your split-second timing is *right* when you use the automatically controlled Standard Stop Clocks. Use them for research and production testing of thermal elements, circuit breakers, relays, fusetrons, fluorescent lamps, engine fuel consumption, speed of moving objects, rate of flow of liquids, etc.

Sturdily built for years of trouble-free service.

30 Days Free Trial

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The STANDARD ELECTRIC TIME CO.
SPRINGFIELD, MASSACHUSETTS

accurately the callender operator could keep the sheet t the required thickness. Having become used to the setting required by the electronic gage, he kept the thickness withi the required 3/1000 tolerance to either side quite well for a day or so, but after that he drifted off to over- or under thicknesses of nearly 50% of the entire thickness of th sheet. When the management took account of the loss thi entailed in stalled assembly lines, in injury to its trad name by defective products, etc., it realized that insurance of the quality of the product, insurance of sustained pro duction, etc., secured at the cost of leasing the gaging ma chines, was a bargain.

In short, there is no economy in "economizing" on instru mentation.

Create Jobs Through Quality Products

FIFTH PRIZE

By ERWIN H. WALDMAN

Operating Dep't, Andrews Steel Co., Newport, Ky.

Erwin H. Waldman grad. from Tech H.S., St Cloud, Minn. Attended Ohio Mech. Inst. and Cincinnati U. Principal studies, chemistry and metallurgy. His experience has included arc and acetylene welding, steel treating, forging and pyrometry, supplemented by trips to steel districts for study on his own funds. "As a workman in various capacities" he studied modern open-hearth, soaking pit and mill practice, including steel mill instrumentation. Simultaneously did lab and research work on his own time. Invented a welding electrode. Wrote paper on use of optical pyrometer in open-hearth practice. Member Army Ordnance Ass'n.

THE present trend toward stabilization of certain determining items of cost and price, through legislation and contract agreements, has made *quality* become a factor of major importance in a competitive market.

To thoroughly consider the influence of instrumentation upon employment, it is necessary to present a picture of the place quality occupies in the cycle contributing to increased business as well as the efforts to secure such quality.

The steel business affords an excellent illustration. To adequately conceive the place of quality in the market, we need only to consider the number of steel corporations and smaller steel companies which remained solvent during years of depression and in the face of ill-advised, inopportune legislation and cheap imported iron and steel.

Conversely, it is an obvious fact that in times of greater demand, the corporation or company producing most consistently the best quality iron and steel, proportionately increases its business and operations.

The very fact that steel today is produced to meet definite chemical and physical specifications, presents a basis for the foregoing statements.

Production of iron and steel to meet certain definite specifications also indicates development of result-producing procedures.

A consideration of the detailed procedure to produce a continuous flow of high-quality product should bring out the fact that the basic underlying principle is use of instruments as tools.

Progressive engineers and informed operators are using instruments with the same viewpoint and after the manner in which a machinist uses his micrometers.

The instrument in the operating departments is coördinated with experience and calibrated to a respective operation. In the hands of experienced operators, the instrument as a tool enables the operator during a respective operation, to arrive at a respective point factor necessary to desired quality and to produce a continuous flow of like quality.

The use of instruments for checking results and for research being the very foundation of the engineering labora-

tory, obviously does not need elaboration here, though it has a bearing on quality.

There will be presented brief illustrations of quality-control instrumentation in the operating departments.

It is logical to start with the open hearth, or "melting department," as it were. Here we have an instrument for rapid determination of carbon content of steel bath.[1] Also optical pyrometers for determining and standardizing tapping and teeming temperatures of various kinds of irons and steels.[2] Also an automatic optical pyrometer controller which is set to record the temperature of an open-hearth furnace roof, and to control the fuel in such a manner so as to keep the roof temperature below the maximum safe temperature.[3] Also regulators for gas producers, which regulate the pressure and volume of gas to proportion to the amount consumed.[4]

Coming to the mill department, we consider first the "soaking pits." Here an automatic fuel control instrument regulates the mixture of gas and air coming into a soaking pit, based upon automatized continuous analysis of percent of CO and CO_2 in outgoing gases; also a thermo-electric potentiometer pyrometer which not only indicates the temperature of the soaking pit atmosphere, front, back and middle of the pit, but can be set to automatically control fuel and dampers of the pit so that a desired temperature for steel can be reached and maintained.[5]

Subsequently, attention is next turned to the blooming mill. A modern blooming mill is equipped with the photo-electric pyrometer which indicates in the flash of a few seconds, and records, the rolling temperature of every ingot of steel as it is rolled. The temperature can be noted at any desired pass during the rolling operation. This enables the operators to secure a desired standard rolling temperature for every kind of steel.[6]

At the bar mills, the same type of radiation pyrometer is used and is calibrated to accurately indicate lower temperature ranges. This pyrometer is so arranged as to accurately determine finishing temperatures. This enables the operators to secure desired standard finishing rolling temperatures for various irons and steels.[7]

These illustrations of the vital points of steel mill operations where new instrumentation has already met with encouraging success, may be presented as sufficient examples.

Quality, and the use of the instrument as a tool to obtain it, are basic factors and as such are broadly applicable to any business requiring precision production.

The ultimate results and the contributing factors are bound to exercise a commensurate influence on our domestic markets and on American supremacy in foreign markets, thus establishing a healthy stimulus for increased business and operations and proportionately increased employment.

[1]Republic Steel Corp., also some plants of other steel corporations.
[2]Most large corporations such as U. S. Steel, Republic Steel, Jones & Laughlin, etc.
[3]Experimental stage, Gary Works of U. S. Steel.
[4]Andrews Steel Co.
[5]Experimented with on surface combustion soaking pit—Andrews Steel Co.; automatic controlled soaking pits in operation—Steel Company of Canada, Hamilton, Ontario.
[6]Indicators located in blooming mill pulpit and at soaking pits—Andrews Steel Co.
[7]In use at Andrews Steel Co.

Floyd K. Richtmyer

With deep regret we chronicle the death on November 7 of Professor Floyd Karker Richtmyer, eminent physicist, Dean of the Graduate School at Cornell University, co-founder of the *Journal of the Optical Society and Review of Scientific Instruments* and since 1930—when this became two publications—Editor of the *Journal of the Optical Society of America* as well as of *The Review of Scientific Instruments*. To many of our readers he has long been known not only for his guidance of these two valuable journals, but as the author of that instructive and fascinating book, his well-known "Introduction to Modern Physics"—a work which for many years more will remain the standard introduction to post-Einstein physical sciences.

Only Trustworthy Instruments Save Money

IN general, the slogan "Instruments Save Money" is perfectly true, but in any particular case—yours, for example—only the trustworthy instruments *can* save money. Since 1867, Moeller instruments have been saving money in various American industries. Their USERS declare that they are trustworthy. These users include gigantic corporations and world-famed laboratories as well as small plants.

THE 1940 LINE of Moeller precision grade instruments embodies further improvements based on past experience and designed for even greater economies in the future.

Industrial Thermometers with the easy-to-read Moeller Glass RED Reading Column; ranges to 1125° F. or equivalent; all industrial forms, sizes, bulbs, sockets, etc.

Engraved Stem Thermometers, with Moeller Glass RED Reading Column, in all laboratory and test ranges; plain or armored, including pocket and special-purpose models.

Recording Thermometers, mercury-filled; single or multiple pen; flush, wall, portable, etc. Over fifty ranges.

Dial Thermometers, mercury-filled; 4½", 6", 8", 10" and 12"; over fifty ranges.

Hygrometers, wet-and dry-bulb thermometer types.

Recording Psychrometers, self-contained or long-distance.

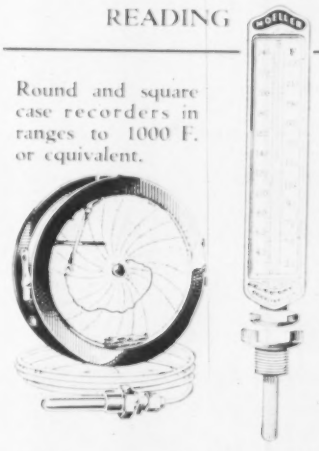
Barometers, mercurial.

Hydrometers

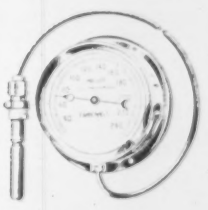
Marine Instruments, etc.

Mercury-in-glass thermometers with the Moeller Glass RED READING COLUMN

Round and square case recorders in ranges to 1000° F. or equivalent.



Dial indicating thermometers in metal and Phenolite cases.



MOELLER INSTRUMENT CO.

132nd St. and 89th Ave., Richmond Hill, N. Y.

Boston Chicago Los Angeles Milwaukee
Philadelphia Pittsburgh New Orleans Seattle

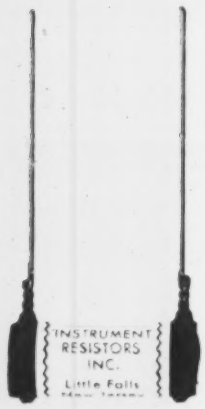
THE MONTH'S NEW INSTRUMENTS

In this department we strive to report each month ALL the new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions.

When writing to manufacturers directly, please mention this department as your source of information.

Or write to Information Section, Instruments Publishing Company.

Resistors

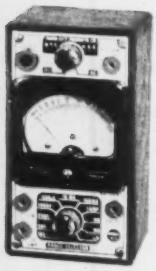


New Types "AL" (illustrated) and "BL," 4- and 6-watt, are said to represent a new development in resistor field, made possible by manufacturer's special winding machine. Max. resistances are 80,000 and 150,000 ohms respectively. Mountings by terminals or center hole. — *Instrument Resistors, Inc., 375 Main St., Little Falls, N. J.*

Clip-on Thermometer for Testing Refrigerators, Etc.

New "Clip-On Superheat Thermometer" has been specially designed for convenience in checking superheat of direct-expansion air-conditioning coils at suction end of each circuit of coil thus assuring correct setting of each flow control valve. It permits checking setting and operation of thermostatic expansion valves for superheat. Temperature of high-pressure liquid entering expansion valve can also be checked. Water type air conditioning coils can be checked likewise. Thermometer tube is adjustable for easy reading from any angle.—*Feddders Mfg. Co., Buffalo, N. Y.*

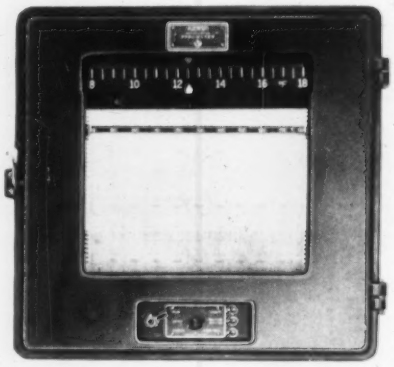
23-Range Pocket Multitester



New "Model 413" provides 23 ranges, sensitivity of 2500-ohms-per-volt for voltage measurements and a low d-c. range of 0-400 microamps; measures 6" long, 3½" wide and 2⅜" deep and weighs 25 oz. Ranges: D-c. volts, 0-10/50/250/1000/5000; a-c. volts, 0-10/50/250/1000/5000; d-c. microamps 0-400; d-c. milliamps 0-10/100/1000; d-c. amps 0-10; ohms 0-500/10,000/100,000/1,000,000 decibels, five ranges from —10 to 69. Indicator is a 3" square, Bakelite encased unit with d'Arsonval 400-microamp. movement employing an Alnico magnet. The multiple scale includes a special scale for low-resistance measurements in which each of first 10 divisions represents 0.1 ohm.—*Radio City Products Co., 88 Park Place, New York City.*

Air-operated Potentiometer Recorder-Controllers

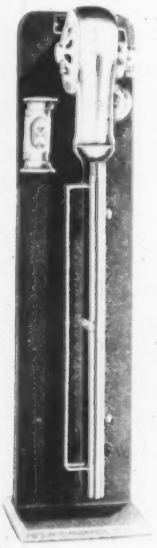
New series of potentiometer recording controllers incorporates three features said to be unique in instruments of this kind: (1) improved detecting mechanism, (2) new integral recording and control mechanism, (3) new control system said to provide maximum flexibility of use. Open-and-shut action or throttling action, with or without automatic reset, is available in air-operated models of the new series of controllers. In order to obtain a detecting mechanism more sensitive than that required for recording (a requisite for good control action), a single calibrated detecting cam is used, which will sense galvanometer pointer deflections of less than 0.0001" without lost motion. By positioning a friction roller, the cam positively determines movement of the integral slide-wire contact, recording and control-actuating carriage. Coordination of measuring, recording and controlling operations is achieved by an integral recording and control mechanism. Slide-wire contact, recording pen and cam follower actuating control cam, are assembled as a unit on rigid carriage, thereby obviating need for linkages, belts or gears to transmit position of one unit to the others. Guaranteed accuracy is 0.25% of scale range. Control system is affixed directly to shaft of cylindrical control cam; resultant self-contained unit requires no linkages. Rotary motion of control-cam shaft makes for extreme simplicity in providing for mode of control required by application. Entire mechanism can be pulled forward out of case and every moving part can be removed or replaced by an inexperienced operator standing squarely in front of the case. This construction allows also the use of anti-vibration rubber-cushioned mountings within case. Routine adjustments for standardizing circuit are made without opening door. *The Foxboro Co., Foxboro, Mass.*



Compact Capacitors

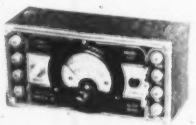
For low-voltage applications which require extremely high capacity for maximum operating effectiveness, "Type FA" capacitor is offered in capacity values up to 2000 mfd., characterized by extreme compactness (as exemplified by "FA-1220" unit which provides 2000 mfd. at 12 volts, and which is 1⅜" diam. by 4⅛" long). Other units vary in size from 1⅜" × 2½" to 2½" × 4⅛". Units are made up in cylindrical aluminum cans with Bakelite terminal caps into which screw terminals are moulded. Over this assembly is a cardboard insulating sleeve. Standard FA units are made for working voltages of 12, 15, 18, 25 and 35 volts, and in capacities of 500, 1000 and 2000 mfd.; higher voltage ratings available on special order. — *Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

Metallography and Spectrography Plate & Film Dryer



By means of new dryer, it is said that photographic plates or films as used in metallographic and spectrographic laboratories may be dried within two minutes, thus avoiding usual half-hour wait. Dryer consists essentially of a motor-driven blower; air is heated to a predetermined temperature by means of an electric heater. Film or plate is held vertically in high-velocity current of heated air.—*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.*

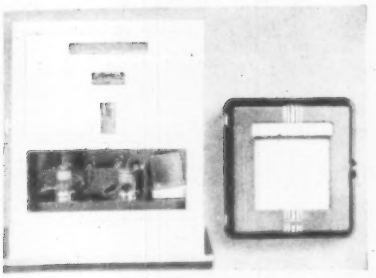
Pocket-size D-c. Tester



Although its metal housing is 5¾" long, 3" wide and 2" deep; and its weight 21 oz., making it a pocket device, new "Model 132 D-c. Trouble Shooter" is said to do a "full-sized job, both as a utility meter and as a trouble shooter." Its indicator is a multi-scale 0-1 ma. d'Arsonval type, accurate to 2%, with a separate scale for the low ohms range said to permit accurate reading of resistance as low as 0.2 ohms. In addition to ohmmeter zero adjustment there is also a mechanical zero adjustment on the meter. Ranges: volts, 0-5/50/500/1000; milliamps 0-1-10; ohms, 0-500/50,000/500,000. Self-contained batteries provide for all ohmmeter ranges and test probes need not be in circuit for balancing ohmmeter circuits. All test probe connections are made by means of tip jacks.—*Redio City Products Co., Inc., 88 Park Place, New York City.*

Oxygen Recorder

Designed for permanent installation and continuous operation, M.S.A. Oxygen Recorder can be calibrated for any range up to 15% concentration, can be used to control oxygen content in chemical processing, to measure oxygen in hydrogen atmospheres, in natural, coke-oven, and blast furnace gases, as well as excess air in products of combustion. Its analyzing section



(left) is essentially a voltaic cell made of hard rubber, containing a strongly reducing electrolyte and two pure copper electrodes. One electrode is submerged, the other—annular—revolves slowly with part of its periphery immersed and the remainder exposed to a continuous gas sample. Oxygen in sample reacts with copper to form copper oxide which, due to rotation, enters solution. The potential set up between copper oxide and copper electrode is proportional to oxygen concentration in sample and is not affected by rate of flow of sample. Analyzer is contained in 26" × 24" × 30" steel cabinet. L&N "Micromax" recording potentiometer (right) is specially designed and calibrated.—*Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa.*

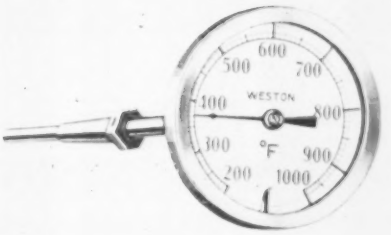
Panel-mounted Receiver for Telemetering System

Designed for power houses, waterworks, etc., where panel-mounted instruments are preferred, "Type PAV" Stevens Long Distance Recorder has been added to maker's

line of water-level telemetering systems (*Instruments*, Dec. 1935, pages 331-2; Jan. 1936, pages 13-14). Available in flush-panel or front-of-panel mountings, it is operated by a Stevens position-motor type transmitter, from any distance up to several miles. Pen reverses its direction at each margin of chart, so that recording range is limited only by length of float line. A five-digit direct-reading water-level indicator may be incorporated at top of recorder case, as illustrated. A number of standard gage scales and time scales are available.—*Leupold, Volpel & Co., 425 N.E. 76th Ave., Portland, Ore.*

Dial Form Stack Thermometer

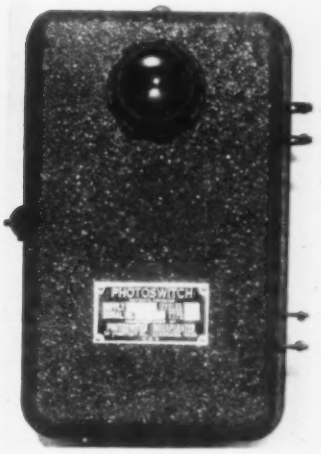
New "Model 5-H-4" stack thermometer enables heating contractors and servicemen to meet requirements of Oil Burner Industry Standards Committee. A sleeve holder



furnished with unit holds its 9" stainless-steel stem in horizontal position in center of the flue gas stream; also prevents dropping thermometer into flue. All-metal construction minimizes ordinary breakage hazards and completely eliminates breakage caused by rapid temperature changes. A shatterproof scale glass is employed. Range is 200 to 1,000° F.; accuracy guaranteed is 1%. Installation for stack temperature measurements in accordance with industry standards requires drilling a 5/16" hole in pipe, inserting tapered sleeve holder until it fits tight, and then slipping thermometer stem through sleeve. For accurate measurement it is only necessary that 4" of the 9" stem be immersed in gas stream.—*Weston Elec. Instrument Corp., 591 Frelinghuysen Ave., Newark, N. J.*

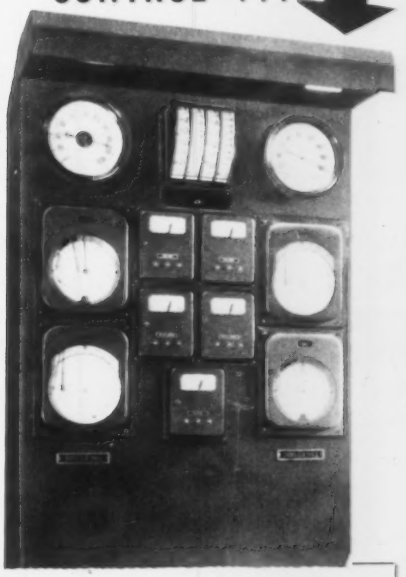
Photoelectric Limit Switch

"Photoswitch Electric Eye Limit Switch" is announced as a low-cost simplified photoelectric unit of rugged construction, suitable for installation in heavy industries where



vibration, humidity, and high temperatures are encountered. It is designed for controlling and limiting the motion of heavy objects such as billets and sheet steel, cranes and hoists, red-hot rods, etc., where maintenance costs of mechanical limit switches are eliminated by substituting light beam control. Two models: "Type A11B" is supplied with light source in weatherproof housings suitable for installation in any location, serves as a general-purpose limit switch. "Type A20C" operates directly from the light given off by red hot metal of any shape, provides limiting control, operates reversing rollers, conveyors, etc., or counts objects. No light source is required and the hot objects may vary in their location with respect to the control within reasonable limits.—*Photoswitch Incorporated, 21 Chestnut St., Cambridge, Mass.*

HERE'S Hays CENTRALIZED COMBUSTION CONTROL . . .



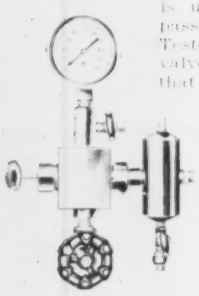
HAYS is the one truly CENTRALIZED control system—All of the control and measuring instruments are contained in one panel. Here is concentrated all information necessary for an intelligent understanding of what is going on inside the furnace, boiler and steam lines. And from this central panel the entire control system or any individual part of it may be operated manually.

Hays Centralized Combustion Control is offered through capable engineering organizations located in all principal cities of the U.S.A. and Canada. Correspondence is invited. Send for our 40-page catalog. Write to 925 Eighth Avenue, Michigan City, Indiana.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROLS
MICHIGAN CITY, INDIANA, U.S.A.

Dew Point Apparatus For Gases Under Pressure

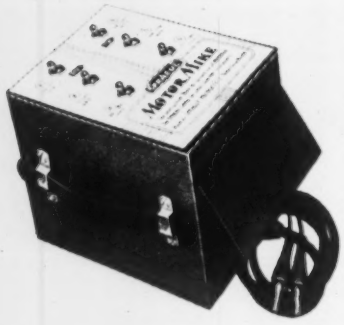
Permitting determination of dew point of gas in a pipeline, this new instrument is designed to operate at pressures up to 2,500 lbs. if necessary; however, standard range is up to 500 lbs. Gas is passed through body of Tester and inlet and outlet valves are so manipulated that pressure in Tester is as near as possible to that in pipeline. In body of Tester,



gas passes over a stainless steel mirror attached to a copper cooling tube. Cooling tube is thermally insulated from its retaining nut and body of apparatus. Refrigeration is supplied by "chiller" unit which has a copper body with a brass header at each end. A number of small holes drilled through body connect the two headers. Expansion of a low-boiling-point hydrocarbon liquid, such as propane or butane, through valve at bottom of chiller unit, forms cold vapors which cool the copper cooling tube and the stainless steel mirror attached thereto. Arrangement thus provides a cold spot for condensation of moisture. Central portion of mirror being at a slightly lower temperature than outer portion, dew first appears there and its detection is aided materially by contrast afforded. Mirror is observed through a Lucite window. By means of an adjustable mirror in front of Lucite window, operator can observe reflected image of stainless-steel mirror, as well as thermometer, from the same position. Mercury-in-glass thermometer is inserted through cooling tube in such manner that it indicates temperature of stainless-steel mirror rather than some compromise temperature influenced by gradient along cooling tube. This apparatus was developed by the Bureau of Mines and is described in its Report of Investigation, 3299.—*The Refinery Supply Co., 624 East Fourth St., Tulsa, Okla.*

Capacity Indicator & Emergency Starting Condenser

New "Motormike" serves as a motor starting capacitor indicator, also as an emergency condenser for 110-volt 60-cycle motors where capacities from 54 mfd. to



180 mfd. are required: It first shows (six steps) what capacity should be used as a replacement on refrigerators, etc.; then, if proper replacement is not immediately available, it can be left in circuit as long as necessary. Steel case, 7½" × 6½" × 6", with carrying handle, contains "Sprague extra heavy-duty sections" which will withstand overloads and can be used for continuous motor-starting service if desired. "Fustats" for protection, are readily accessible through metal flap in front, which also contains space for extra "Fustats."—*Sprague Products Co., North Adams, Mass.*

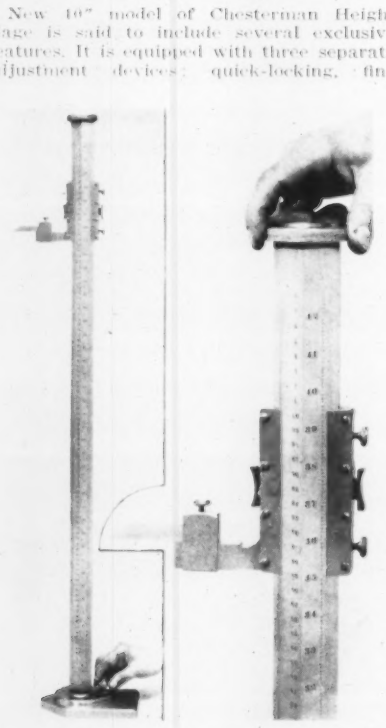
Photoelectric Relay

New "Type RQ Photo-Troller" compact photoelectric relay can be used for counting, sorting, weighing, measuring, signalling, etc.; has two normally-open and two

normally-closed contacts, each rated at 10 amps. on 115-volt a-c. circuits. It operates on a change of 10 foot-candles, if not more than 15 foot-candles of extraneous light is present, increased sensitivity being obtainable by means of a condensing lens. Unit may be wall or bench mounted with open wiring, or with concealed or exposed conduit.—*Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.*

Height Gage

New 40" model of Chesterman Height Gage is said to include several exclusive features. It is equipped with three separate adjustment devices: quick-locking, fine

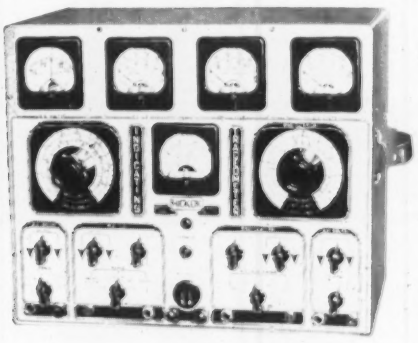


knurled knob at head and "super-fine" adjustment at base. New rigid triangular beam prevents sway and vibration, permits accurate readings as high as 40". Gage is graduated in both English and metric scales to read 1/1000" and 1/50mm. and new "extra-large" vernier is about 2½" long. Chesterman Height Gage also comes in 12", 18" and 24" models.—*George Scherr Co., 128 Lafayette St., New York City.*

RESISTIVITY METHOD PROSPECTING APPARATUS (*Instruments*, Dec. 1938, page 318). ERRATUM—In sixth line of this item, "mill method" should read "null method."

Quintuple-instrument Testing Set

Said to be a "history-making" radio tester, new "Model 155 Tracometer" with its five instruments permits dynamic signal tracing "at its best": measuring and tracing the signal (without interfering with the performance of the set) in any five circuits at the same time, these being the five measurements that can be made simultaneously without disturbing the natural operation of the set: (1) of signal in microvolts at any point in the rf.-if. section; (2) of actual oscillator voltage throughout its entire range; (3) of all d-c. voltages, a.v.c., a.f.c., power supply, etc; (4) of any a.f. or a.c. voltage in any circuits; (5) of actual wattage consumption of any a-c. system to 300 watts. Vacuum-tube voltmeter circuits are so arranged that accidental overload cannot possibly damage instruments. A 5-amp. fuse on the front panel protects entire equipment including wattmeter. Pilot lamp on front panel lights continuously when instrument is in use. Instrument has self-contained voltage regulation for vacuum-tube voltmeter circuits operating the indicating meters. Complete instructions and leads are furnished.—*The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.*



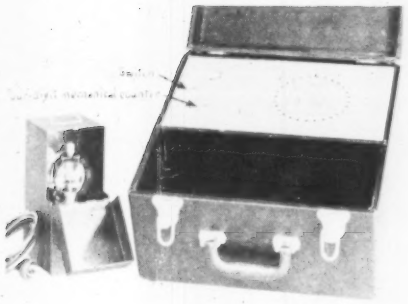
Tube Tester

Improved "Model 308" tube tester (see *Instruments*, Sept. 1938, page 2101) provides facilities for testing "all tubes" and an additional test position is provided for future

tubes with new base arrangements. All tests are made under RMA specified plate voltages and loads. Hot interelement short and leakage tests are provided for between all individual elements, including hot cathode leakage, with "high-sensitivity" neon indicator. Provision is included for audible test of noisy tubes and for testing each section of full-wave rectifiers, duo-diodes and all other multisection tubes. Instrument is adjustable for all line voltages between 105 and 135, with line voltage indicator is checked against a laboratory standard mutual conductance instrument, is available in counter and combination portable-counter types and for 115- or 220-volt operation.—*Radio City Products Co., 88 Park Place, New York City.*

Portable A-c. Operated Ultraviolet Meter

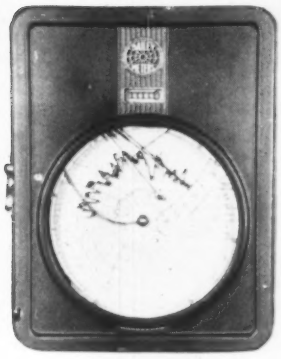
A new portable meter for measuring the output of various types of ultraviolet sources operates from 115-volt a-c. supply. It is a true meter in that it registers the product of intensity and time, instead of indicating the instantaneous intensity. Its primary element is one of three Westinghouse ultraviolet phototubes (one of which is shown at the left in its separate housing which fits into front compartment of carrying case when not in use). Used with a tantalum phototube, meter is useful in measuring output of such u-v. lamps as Westinghouse Sterilamp; with a titanium phototube the meter may be used for measuring solar u-v. radiation or for determining proper time of exposure for sun baths



or sun-lamp treatments; with a platinum phototube the device measures radiations in the ozone-producing region. Amount of u-v. radiation is determined by an integrating method and registered by a mechanical counter. The number of counts registered in a given time is directly proportional to the intensity of u-v. radiations impinging upon the phototube. Complete meter and carrying case weigh about 30 pounds. Phototube, grid-glow tube, and control condenser are mounted in a separate removable housing and attached to the counter mechanism by an extension cord. On a chromium plate inside case are control switch and counter. A full-wave rectifier is built into case. An extension cord is provided for connection with 115-volt outlets.—*Westinghouse Lamp Division, Westinghouse Elec. & Mfg. Co., Bloomfield, N. J.*

Re-designed Flowmeter Casings, etc.

Maker's complete line of recording, integrating and automatic-control fluid meters has been "re-styled" in that refinements have been made in casings, etc;



without making fundamental alterations in measuring and controlling systems of instruments. Durability has been increased by a steel ring welded to casing which serves also as support for a new piano type hinged door. A narrow tray at top of casing prevents dust from falling into meter when door is opened. A new method of preparing casings for application of primers and lacquers is employed.—*Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio.*

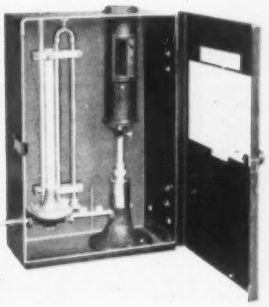
Germicidal Radiation Meter

An easy, inexpensive method of measuring bacteria-killing effectiveness of ultraviolet from germicidal lamps makes use of the G-E light meter; is based on the facts

(1) that u-v. radiation excites certain fluorescing materials, causing them to emit light, and (2) that quartz transmits germicidal u-v. of shorter wavelengths whereas ordinary glass absorbs this energy. Over the light meter cell there is placed a device consisting of an appropriate fluorescing material sandwiched between a plate of clear quartz and one of clear ordinary glass. When quartz side is toward source of germicidal energy, fluorescence is excited by u-v. and longer wavelengths. When glass side is toward source, germicidal energy is absorbed and therefore does not excite fluorescence but energy of longer wavelengths does excite fluorescence. Obviously, difference between light meter readings is a measure of the germicidal energy. —*Lamp Dept., General Electric Co., Nela Park, Cleveland, Ohio.*

B.T.U. Indicator

"Connelly Caloroptic" for determining heat value of any gas—natural, artificial, propane or butane—employs "best flame" principle, flow of primary air at constant



pressure being regulated by a sleeve vernier with 25 divisions, each representing 1 B.t.u./ft.³. Initial calibration having been made against an accepted calorimeter for the particular gas, instrument will then be capable of giving readings with accuracy said to be entirely satisfactory for practical purposes. Since accuracy depends on precision of air flow regulation, and hence on constancy of pressure of air supply, this is accomplished by an adjustable spring-loaded regulator (lower left-hand corner) the action of which is shown by a U-tube manometer made of unbreakable tubing. *Photoelectric Devices.* Above description refers to model illustrated, employing human-eye observation. There are available complete systems wherein a Caloroptic, equipped with photocell, serves for actuating signals and for automatic operation of gas plants, etc. —*Connelly Iron Sponge & Governor Co., 3154 S. California Ave., Chicago, Ill.*

NOW—A NEW

COMPLETELY ASSEMBLED MULTI-PURPOSE, LOW-PRICED

PHOTO ELECTRIC

"ELECTRIC EYE"

EXPERIMENTAL SET

Designed for Executives—Engineers and Maintenance Departments

KEEN management adopts Photo Electric Equipment to protect premises and employees, improve manufacturing processes, increase production, reduce costs, and in advertising and sales promotion work.

Now you can use the amazing, new, inexpensive REHTRON Electric Eye Robot Experimental Set to help determine how and where photo electric equipment can be profitably employed in your business. The REHTRON Set is designed to demonstrate and duplicate nearly all applications of commercial photo electric equipment.

The REHTRON Set is NOT A TOY OR NOVELTY and may be actually used as an Invisible-Beam Electric Eye Burglar Alarm; Fire Alarm; Smoke Indicator and Control; Liquid Level and Turbidity Control; to operate a Magnetic Counter or Power Relay; and to simulate other industrial controls. Special Adapter furnished makes Robot a sensitive, wonder-working Capacity or Touch-Relay for thermostatic, moisture content, flame or other Control application.

Complete Set consists of: *1.* Robot Control Relay assembled in heavy gauge, black wrinkle finished metal housing. Sensitive, self-shielded, commercial type (caesium) Photo Cell and low wattage power tube included. Has rubber cord and plug for inserting into electrical outlet. Size 6 x 4 x 2 in.; *2.* Signal-Switch Panel Board, 6 x 7½ in. black ebony finish, parts for audible and visible signals assembled, wired and connected to Robot; *3.* Light source Unit has transformer, cord and plug, bulb and socket, rotary switch, fixed-focus lens, removable Infra-Red filter, adjustable mounting base. Made of heavy gauge metal, black wrinkle finish, size 5 x 2½ x 2 in. Light Source controls Robot up to 20 ft. with filter—30 ft. with white light; *4.* Complete instructions, diagrams and suggestions for applications and experiments.

Set operates on 110-120V., 60 cycle A.C. Relay contacts deliver 6V. ⅓ amp. A.C., selective open or closed circuit. No batteries needed. Easily adjusts for sensitive, stable operation. SATISFACTORY PERFORMANCE GUARANTEED. Value far exceeds LOW PRICE OF ONLY $17.50 F.O.B. Chicago. Shipped open acct. to rated firms. Exp. chgs. prepaid in U.S. when check or M.O. accompanies purchase order. Specify Cat. No. E-77. Literature and information on REHTRON commercial units on request.

REHTRON CORPORATION

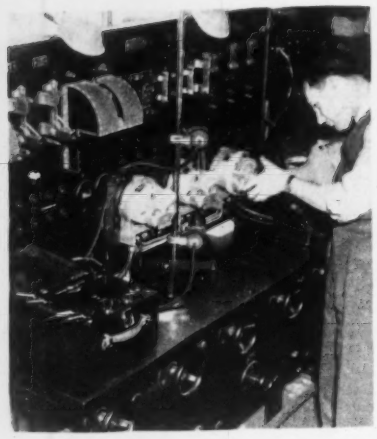
Mfrs. Rehtron Photo-Electric Equipment Burglar Alarms

2159 MAGNOLIA AVENUE

CHICAGO, ILLINOIS

Photoelectric Type Watthour Meter Tester

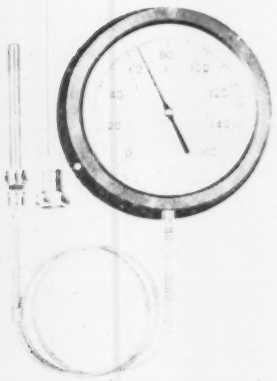
Making it possible to calibrate many more watthour meters than by hand, new "Photo Tester" is an automatic device employing phototube and relays to count revo-



lutions of meter under test and to start and stop the rotating standard in accordance with predetermined number of revolutions. Instrument is accurate to 0.001% in one revolution and 0.0001% in 10 revolutions. Over-all accuracy depends on the rotating standard but timing error is negligible. Direct savings may be made with this instrument as it does not require an operator to watch and time the running. In addition, degree of accuracy permits halving the running time ordinarily used; and repeat runs are unnecessary. Other uses include checking accuracy of rotating standards by primary standard method, starting and stopping meters in gang testing for which an auxiliary relay is required, and testing watthour meters by the synchronous clock method. Terminals are provided so that a chronograph or similar device may be actuated. For polyphase meters of the "Y" type which do not have creep holes in disk, a small mirror is provided for attachment to the rotating shaft without changes or marks being made on meter disk.—*General Electric Co., Schenectady, N. Y.*

Dial Thermometers

In addition to new line of recording thermometers (*Instruments*, Dec. 1939, page 318) there is announced a line of mercury-actuated dial thermometers in 8"



cases, with non-reflecting white dials enhancing intrinsic precision.—*The Palmer Co., 2511 Norwood Ave., Cincinnati, Norwood, Ohio.*

Moisture Meter

To maker's line of moisture-content measuring instruments has been added a "Moisture Teller" (see *Instruments*, June 1935, page 161; Feb. 1939, page 54) that takes a sample pan 2¾" in diameter and 1¼" in depth. Bottom of sample pan is made of 500 mesh Monel filter cloth. Pan, containing sample to be dried, is placed under heated air outlet. Moisture in sample is flashed to steam and blown through bottom of the pan. Sample is dried to constant weight in as little as one minute for many materials. Pan in new instrument is so small and light that it may be weighed on a sensitive analytical balance. Temperature of drying air is automatically controlled by means of an adjustable thermostat.—*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.*

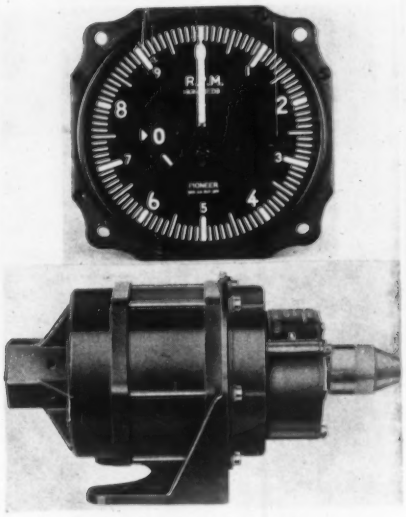
Sight Flow Indicator

Visible-flow fitting has been developed to provide continuous check on operation of equipment and observe fluid in flow under pressures up to 125 lbs. in.²; has been de-

signed in six sizes for 2½" to 8" lines. Body is of cast iron, window frame of steel, windows of Pyrex glass. Sight glass fitting is flanged for installation and all sizes measure 13¾" between finished surfaces. Windows are 4¼" diam. for all sizes. Weights range from 15 to 215 lbs.—*Cochrane Corp., 17th St. & Allegheny Ave., Philadelphia, Pa.*

Electric Tachometer for Aircraft

New "Sensitive Electric Tachometer with "Pioneer Micrometer Dial" is said to possess every characteristic desirable in an aircraft tachometer, including simplicity of



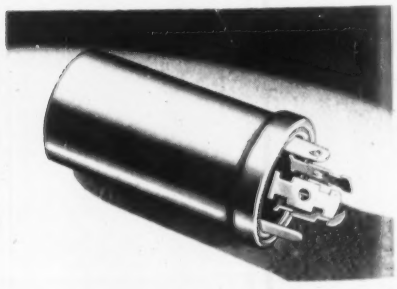
installation and thorough serviceability. Transmitter is a 3-phase alternator designed for mounting in nacelle; receiver contains a small 3-phase synchronous motor. This motor runs in synchronism with engine-driven alternator and drives a magnetic drag tachometer element. Drag element material is a special alloy with extremely low temperature coefficient of resistivity and high electrical conductivity. A rotating magnet and fixed temperature compensator likewise are of special alloys; and combination is said to assure permanence of calibration. A novel construction of magnetic drag element prevents end play in magnetic drag cup shaft from impairing accuracy. "Pioneer Micrometer Dial" permits use of an extremely simple gear train in tachometer mechanism; single pinion and underdial gear are designed, cut and meshed to minimize friction and wear. Scale is calibrated so that one pointer revolution indicates 1000 r.p.m.; thousands are indicated on underdial. Use of only one pointer prevents confusing tachometer with other instruments.—*Pioneer Instrument Co., 74 Lexington Ave., Brooklyn, N. Y.*

Motor-starting Capacitors

"Type ETN" a-c. electrolytic capacitors for motor-starting uses are said to provide a combination of characteristics to meet requirements either as original equipment or replacement. They are of the etched-foil type, with safety vents to take care of excessive internal pressure resulting from accidental or abnormal conditions. Each unit is jacketed with a moisture-proof cardboard sleeve of high electrical insulation qualities. Some are available with steel end caps with inset rubber grommets, through which wire leads are brought; or with these end caps and steel mounting brackets. Standard units are available with rated working voltages of 110, 125 and 220, 50-60 cycles, in capacities from 10 to 198 mfd. Sizes from 1.425" diam. × 2⅝" long for lowest capacity to 2.55" × 4½" for largest unit. Metal end caps increase these diameters ⅛" and lengths 1¼".—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

Midget Electrolytic Capacitors

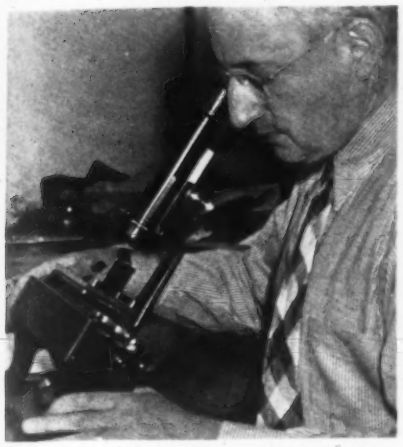
Prong-base midget can electrolytic capacitors are announced. Mounting prongs slip into an elliptic fibre supporting washer (insulated can) or metal washer (ground-



ed can) riveted or eyeletted on chassis and bent over. Terminal lugs slip through hole in washer, for soldered connection. Units incorporate standard Aerovox wet electrolytic sections. Hermetically sealed. Safety vent. Negative can. Single and multiple-section units.—*Aerovox Corp., New Bedford, Mass.*

Refractometer for Glass

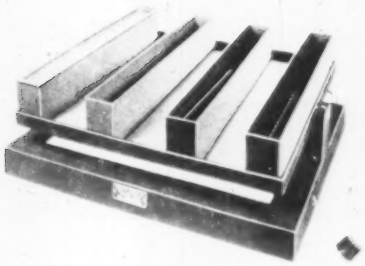
Though smaller and much less costly than previous instruments, a new refractometer for measuring the refraction index of glass is said to be accurate to two deci-



mal places and equal to most laboratory tasks. Principal parts are a telescope and a polished metal prism. One surface of the latter is vertical and another at an angle of 45° from axis of telescope. Springs hold the sample of glass to be tested against these faces while measurements are taken. Angle of tilt being fixed at 45° by the prism, only thickness of glass and amount of displacement of an object viewed through it need be measured. Thickness is measured by placing sample against vertical face and taking comparator readings. Attached to tilted surface of prism is a piece of drawing paper on which a large dot has been made with black ink. Displacement is measured by adjusting base until telescope cross-hair is tangent to dot as viewed directly and then through test glass. Difference is the optical displacement. With this datum the index of refraction can be determined by slide rule and reference to tables. For study of thick glass, use of a sodium lamp as an illuminant has been found advantageous. Illustration shows instrument in use by G-E Research Laboratory physicist Frank Benford, who devised it.—*General Electric Co., Schenectady, N. Y.*

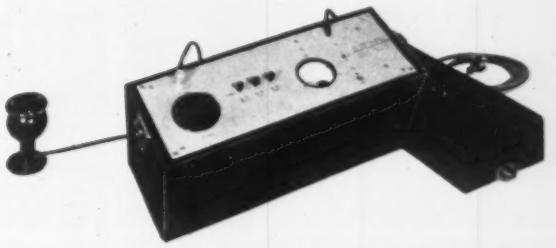
Developing Unit

Particularly designed for service in processing plates or films in spectrographic and metallographic laboratories, new photographic plate or film developing unit has a



pivoted top table which is rocked by means of a motor-driven cam. The developing, stop, hardening and fixing solutions are automatically controlled at 70° F. by means of water circulating through a copper coil attached to bottom of rocking table. When new developing unit is used, it is said, plate or film may be processed within two minutes' time uniformly without grain growth.—*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.*

Here's the only
AC-OPERATED NOISE METER



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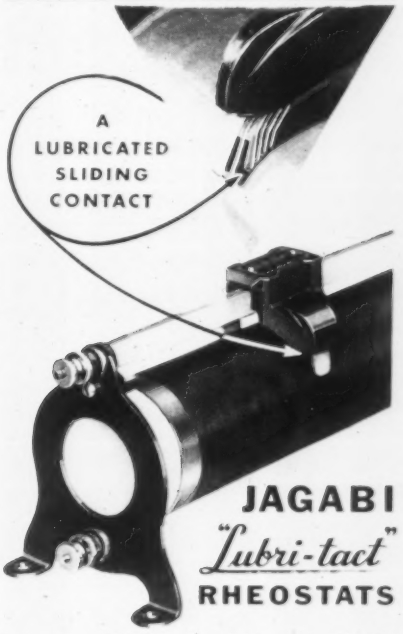

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have a graphited carbon lubricator associated with the contact brushes. Eliminates scratching and abrasion—gives smoother operation and a better contact. Makes Jagabi Rheostats *better* rheostats.

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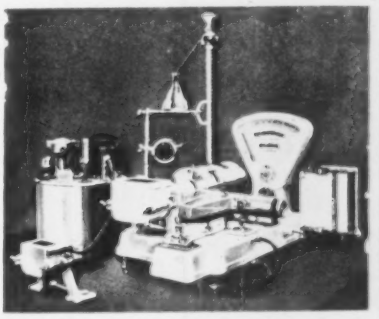
PLASTOGRAPH



Recording Plastometer—based on the dynamometer principle and practically "weighing" the plasticity of the different materials. Measures consistency over a wide range of materials—from fairly viscous, syrupy substances to unvulcanized rubber. Has been applied successfully in RESEARCH as well as in PLANT CONTROL (for continuous operation) in the following industries:

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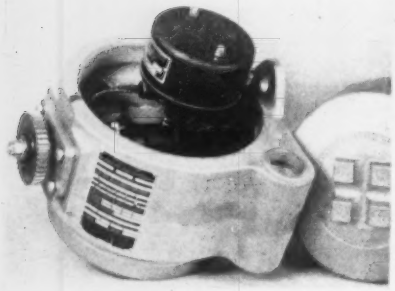
Can be supplied with various types of mixers or agitators—all water jacketed for efficient temperature control. Has three different sensitivity settings and can measure and record within each desired range with three times and five times increased sensitivity by the simple expedient of zero-suppression.

Pamphlet on Request

BRABENDER CORPORATION
ROCHELLE PARK, N. J.

Explosion-proof Electric Tachometer

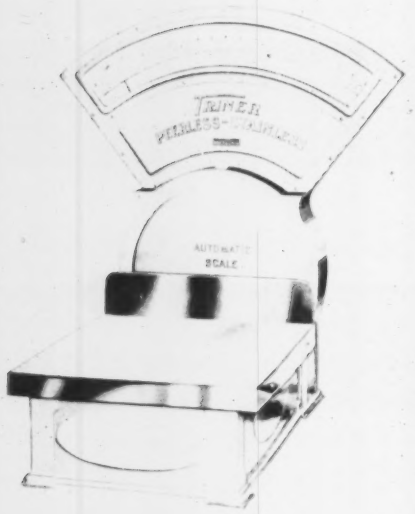
Designed for hazardous locations, new development makes possible remote indication of speed or rate of production of machinery operated in presence of explosive



gases or vapor. Safety is due to installation in an approved housing according to Underwriters' specifications for Class 1, Group D, atmospheres. Illustration shows new "Type M-400" heavy-duty Tachometer Generator with gearbox which simplifies drive from any shaft having maximum speeds as low as 100 r.p.m. or as high as 5000 r.p.m. Any design of shaft extension or drive accessories furnished to order. Indicating instrument is furnished with any desired scale, with or without approved explosion-proof housing. Manufacturer is also prepared to furnish on special order Electric Speed Recorder, Type R-300 (see adv. in this issue) in explosion-proof housing for hazardous locations.—*The Electric Tachometer Corp., 1358 Spring Garden St., Philadelphia, Pa.*

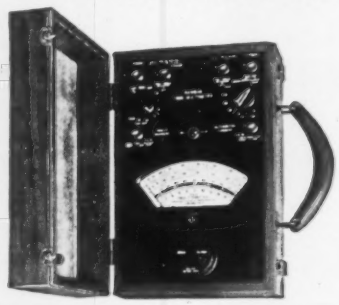
Corrosion-resistant Scale

New "Model SS-18" corrosion-resistant scale is offered in two choices of materials: (1) Combination Monel and Stainless Steel, which will resist salt and brine



action, (2) All Stainless Steel, for use in resisting acids and fumes as well as salt. In both styles, shields, overlapping flanges, cups, drains and seals are provided to decrease likelihood of moisture, materials and cleaning compounds finding their way into working parts. Maker's double-pendulum ("no springs") gravitational action is employed, with oil-dashpot control of moving parts. Platform 15 × 16" with 3" up flange, base of scale 14 × 24", overall height 27½". Capacities 30, 40, 50, 60, 70 and 100 lbs.—*Triner Sales Co., 222 West North Bank Drive, Chicago, Ill.*

Rawson Twin Multimeter



29 ranges in less space than any near equivalent combination—size 12" x 8" x 6"

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D.C. 1 microampere to 1 ampere
20 microvolts to 1000 volts
A.C. (up to 3000 cycles)
2 milliamperes to 3 amperes
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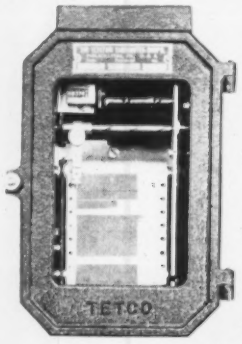

Creates a permanent time record on a waxed chart. Accurately records rate of production, time and duration of stops, total quantity produced.

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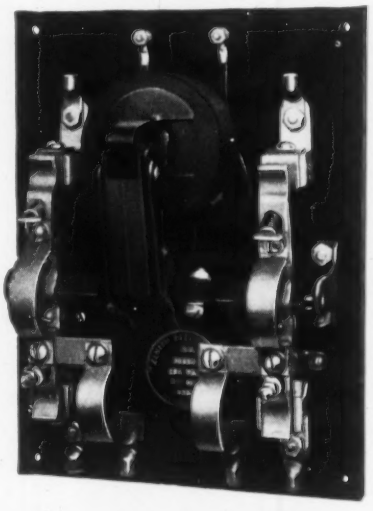
General-purpose Time Switch

Smaller and lighter than previous model, new "T-44" time switch is furnished with a plain or an astronomic dial for turning circuits on and off at dusk and dawn; for

switching two circuits simultaneously on and separately off; for switching two circuits separately on and simultaneously off. It makes and breaks 25 amps. Mazda, inductive or resistance loads. An omitting device permits skipping the "on" operation on selected days of the week.—*General Electric Co., Schenectady, N. Y.*

Automatic Transfer Switch

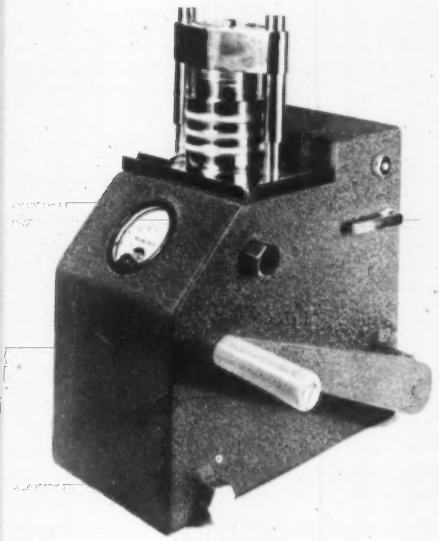
Spring gravity drop-out type automatic transfer switch for automatically connecting a lighting or power load to an emergency source in case of failure, is available



in 1-, 2-, 3- or 4-pole construction (2-pole illustrated), for a.c. or d.c. to either a.c. or d.c., standard voltages, capacities from 30 to 300 amps. Switch will transfer when voltage of circuit drops to 70% or less and will restore load to normal source when voltage reaches 90%. Any part of assembly can be inspected or replaced without disturbing other parts. Switches can be mounted in any position. Special combinations of poles and contacts for pilot lights and signals can be furnished, as well as back-connected switches.—*Zenith Electric Co., 845 South Wabash Ave., Chicago, Ill.*

Moisture Meter for Granular Materials

New "Granular Moisture Register" employs an adaptation of maker's "Lumber Moisture Register" for granular, pelletted, powdered and loose pulp materials. Sample



is placed in cup at top of machine and operation of crank lever produces hydraulic pressure to squeeze air from sample, after which measurement is made by operating small switch lever. Same lever, thrown to upward position releases hydraulic pressure and returns plunger to open. Readings are said to be independent of room temperature, humidity, or temperature of sample in normal ranges, and unaffected by dielectric constant of material under test. Determination can be made in less than one minute without necessity of a skilled operator. Instrument is sold under one year guarantee "against defects . . . including change of accuracy," is supplied with dial reading in moisture percent or with arbitrary numerical scale, is self-contained and portable, weighs 40 lbs., is 11" high by 11" deep by 7" wide, and powered by low-cost batteries which manufacturer claims will give at least one year of ordinary service.—*The Moisture Register Co., 1029 N. Sycamore St., Los Angeles, Calif.*

Shockproof Multi-purpose Watch in Waterproof Case

New "No. 490W Time Study Precision Chronograph" performs same functions as "No. 460 Multi-Purpose Chronograph" described in *Instruments*, May 1939, page

136; but is characterized by two improvements: It is waterproof—makers assert that "you can swim with it"—and it is equipped with the "Incabloc" protector which renders it resistant to shocks such as dropping from table height. Illustration is full-size.—*Jardur Import Co., 21 West 19th St., New York City.*

A Large University Says:

"We have two of your Portable Pyrometers that have proved very satisfactory and we want to order another one. Please quote us."

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You, too, will say that it is very satisfactory for temperature measurement and checking. Let us tell you what it will do for you.

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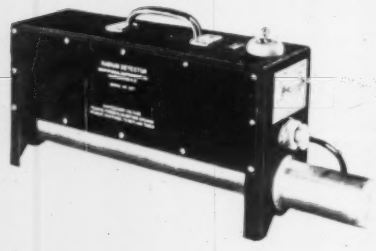
Radium Detector

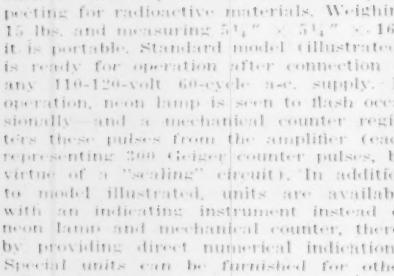
Designed for measuring quantity of radioactive material present, new Geiger Counter Type Radium Detector is applicable to research work in addition to qualitative uses



such as discovery of lost radium and prospecting for radioactive materials. Weighing 15 lbs. and measuring 5¼" × 5¼" × 16", it is portable. Standard model (illustrated) is ready for operation after connection to any 110-120-volt 60-cycle a.c. supply. In operation, neon lamp is seen to flash occasionally—and a mechanical counter registers these pulses from the amplifier (each representing 300 Geiger counter pulses, by virtue of a "scaling" circuit). In addition to model illustrated, units are available with an indicating instrument instead of neon lamp and mechanical counter, thereby providing direct numerical indications. Special units can be furnished for other voltages and frequencies; or battery-operated for field work. The Geiger counter tube, a recently improved model, is available by itself.—*Geophysical Instrument Co., 1315 Half St., S.E., Washington, D. C.*

Automatic Control for Electric Heating Equipment

New "Reactrol" system for automatically controlling electrically heated equipments, such as furnaces, boilers, superheaters and air heaters, regulates power input by varying the voltage impressed on the heating resistors in accordance with temperature or pressure requirements. It is particularly suitable for continuous processes and in treatment of materials that might be affected by slight changes in temperature. In its simplest form, Reactrol system consists of a control panel (lower left-hand position of panel illustrated), a temperature or pressure control instrument, and a saturable-core reactor. In operation, pressure or temperature control instrument (which contains a special potentiometer) feeds low-voltage current into an amplifying tube on control panel. This tube, in turn, regulates the flow of direct current to the saturable-core reactor which, acting like a valve, regulates voltage, and hence power input. System is said to provide accurate and rapid temperature or pressure control with practically no overshooting.—*General Electric Co., Schenectady, N. Y.*



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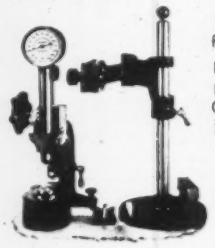

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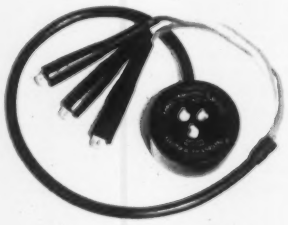

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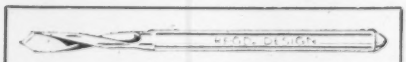

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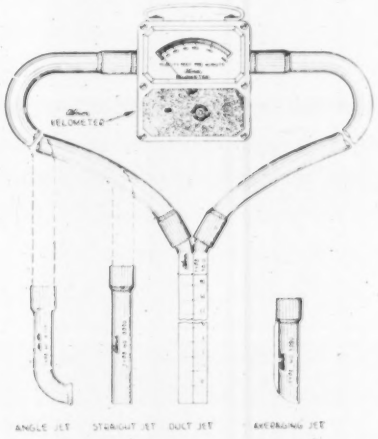
Mankato, Minnesota

Low-velocity Fittings for Direct-reading Anemometer

In order to extend range of applications of Boyle System "Velometer" (*Instruments*, July 1935, page 191; Dec. 1935, page 343; July 1936, page 177; Apr. 1937, page 94) makers have brought out a series of "Jets" designed for low velocities; larger than standard devices and differing also in design. Accurate readings are said to be obtainable at air velocities of the order of 20 f.p.m. or 4" per second.—*Illinois Testing Labs., 111 W. Austin St., Chicago, Ill.*

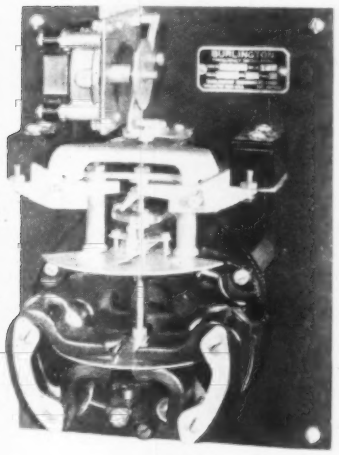


Portable A-c. Timer

New portable timer unit, designed for a.c. operation only, is mounted in Bakelite housing with base, equipped with cord and series wired outlet tap, celluloid-covered dial. Silver contact switch has a capacity of 15 amps at 120 volts a.c. Timer can be supplied in 15-, 30- and 60-minute maximum timing range. To operate, pointer is turned to any desired interval; for short interval settings (between zero and six) pointer is turned to star to close switch circuit and then returned for interval required.—*Walser Automatic Timer Co., Grauhar Bldg., New York City.*

Automatic Frequency Regulating System

New Burlington Electrical Frequency Regulator has been "particularly invented and designed for the purpose of more closely controlling the frequency of a-c. generators." It is interposed between outgoing circuit and governor of turbine or other engine mover. Through its use, small errors of timing are prevented from accumulating in the outgoing circuit from slight errors which might accrue in the horological system. Announcement lays stress on component parts being mainly equipment now



richly developed and in production. Device consists essentially of an induction type directional power relay, used in conjunction with a tuned resonant filter circuit. Tuned resonant filter consists of a plate condenser connected permanently in multiple with an inductive reactor, the volt-ampere capacity of which will exactly neutralize the v-a. capacity of the condenser at 60 cycles or any other frequency for which regulator may be designed to operate. Current coil of induction relay is connected in series with resonant filter, all of which is excited by a potential having a quadrature angular displacement from the voltage exciting the potential coil of the induction relay. Because of this quadrature relationship the induction relay is rendered irresponsive of the current supplying the copper and core loss of the reactor and the wattage loss of the condenser, and is responsive only to condensive or reactive current passed by the resonant filter. The condensive current component predominates for high frequency, causing the relay element to rotate in one direction so as to close its s-p-d-t. contacts for frequency reduction, whereas a reactive current component will predominate for low frequency conditions, producing relay rotation in the oprosite direction. A cam arrangement provides for directing corrective impulses so as to quickly restore the frequency to normal without hunting, yet maintaining the corrective impulse period in proportion to frequency deviation. When the frequency varies from the control setting, regulator directs the rotation of governor control motor, which changes tension of control spring on prime mover governor, thereby correcting the frequency. Cam-operated switch causes corrective impulse to be broken up into intervals depending upon the responsiveness of the generating system to changes in frequency. Frequency variations of 0.01 cycle can be corrected, since there is practically no limit to sensitivity of basic principle employed.

Described above is control equipment *not* provided with time make-up compensation; it may permit a slight deviation of synchronous clocks from correct time after a "considerable period of time" has elapsed. Directional relay is therefore provided with an adjustment, so that if operator observes clocks to be fast or slow, he may make an appropriate compensation.

Time Make-up Device is so designed that automatic time error compensation is accomplished by the interaction of a master clock, a differential device and a synchronous clock motor, cooperating with the directional relay. Differential device operates by photoelectric means, thereby imposing no mechanical burden upon station master clock. Swinging pendulum of master clock intercepts a beam of light focused on a photo cell. The frequency of these interruptions is then arranged to control the frequency of the electrical generating system. —*Burlington Instrument Corp., Burlington, Iowa.*

Variable Transformer

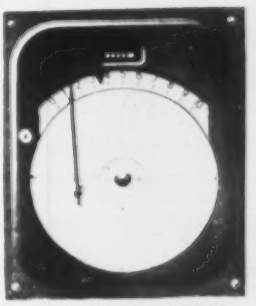
For obtaining a manually adjustable source of a-c. voltage for electrical testing and for control of electric heating or lighting, new "Powerstat" variable transformer

is available in sizes from 2 to 25 kva. for single- or three-phase operation on 115-, 230-, and 440-volt circuits. Output voltages are adjustable from zero to above line values. Characteristics are "good regulation, high efficiency, low weight and smooth control." Large models are wound with glass insulated wire while smaller units employ high-strength polyvinyl resin insulation. Cast parts are of aluminum alloy. A 7.5-kva. 230-volt unit has a no-load power loss of 16 watts. —*Superior Electric Co., 61 Harrison St., Bristol, Conn.*

Accuracy . . .

IS VITALLY IMPORTANT!

Distinguished for extreme accuracy and high quality, Cochrane Flow Meters are reliable Instruments for computing records of consumption, intake, output and variation in the rate of flow of steam, gases, water and other liquids. The Electric Model utilizes the galvanometer null principle.



ELECTRIC MODEL

The sensitive galvanometer detects the slightest change in rate of liquid flow, unaffected by friction or variations in voltage or frequency. Can be installed any distance from pipe line. The mechanical model develops an extremely high torque, is accurate in design, simple and rugged in construction.

MECHANICAL MODEL

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INSTRUMENTS' BOOK SHELF

Spectrographic Analysis in Great Britain. Edited by A. C. CANDLER, Adam Hilger Ltd., London, 1939. Limp cloth, 6 × 9½ inches. 80 pages. Price 7s/9d.

This volume collects 28 reports from institutions and industrial firms in Great Britain which are using the spectroscope for chemical analysis. Nearly the whole range of analysis is covered by these reports, which include the routine analysis of iron alloys for shop control and the examination of paint on a burglar's tools.

In the sugar refining industry the detection of minute traces of metals in the raw or semi-refined material has indicated the course to be followed in obtaining a finished product free from these impurities. The spectroscopic examination of sources of water has proved to be helpful to the fermentation industries. Art and archaeology have profited by spectroscopy, largely because the analysis can be made without injuring the object. The investigation of diseases of crops and stocks has made use of the fact that the spectroscope can find traces of metals which are too minute to be detected by any other means. Other uses of spectrochemistry are similar to those with which we are all becoming increasingly familiar; still, we find many useful hints in the pages of this report devoted to these familiar analyses.

—KELVIN BURNS, *Astronomer, Allegheny Observatory, Pittsburgh.* (7.5)

Optische Pyrometrie. By FRITZ HOFFMANN and CARL TINGWALDT. Friedr. Vieweg & Sohn, Braunschweig, 1938. Paper, 5½ × 8½ inches, vii + 134 pages. Price 9RM.

This book is divided into twelve chapters. In the first chapter fundamental concepts such as radiation from a surface in a particular direction and the integration for all directions are discussed in keeping with modern theory on this subject. The principal radiation laws—Kirchhoff, Stefan-Boltzman, Wien-Planck and Wien's Displacement Law—are given and their applications pointed out. (The actual form of the Wien Displacement Law is not as definitely given as one might wish.) There is one slip on page 6: The constant σ is given as usual so that this constant times the temperature to the fourth power gives the total radiation within a solid angle 2π from a blackbody of unit area. Equation 7_a says that this constant σ divided by π and multiplied by the temperature to the fourth power gives the total radiation in a unit solid angle. This should be *per* unit solid angle. There is but about 92% of this amount of radiation in the unit solid angle. On the same page there is a misprint in the value of the constant, 1.732 being given for 1.372.

The second chapter discusses the construction and operation of blackbodies. Diagrams showing the construction of several forms are given.

Then follow five or six chapters in which various forms of pyrometers including total radiation, and optical are discussed with diagrams and working relations. The advantages and disadvantages of the different types are pointed out and the latest models intended to overcome some of the disadvantages of earlier models are shown by diagrams. The effective wave-length of the monochromatic screen used and the use of spectrometers in constructing a spectral pyrometer are gone into quite fully. The measurement of the temperature of non-blackbodies is considered; the necessity of knowing the emissivity of these radiators is pointed out and some methods are given for measuring this factor.

Chapter 10 discusses methods of giving the distribution of energy in the visible spectrum of different radiators by giving their color temperature or by the use of the color triangle.

Chapter 11 is devoted to a determination of the temperature of solid and liquid bodies that are not blackbodies. The method of determining the emissive power by measuring the reflecting factor of different radiators is given. The polarization of the radiation from different sources at different angles is discussed.

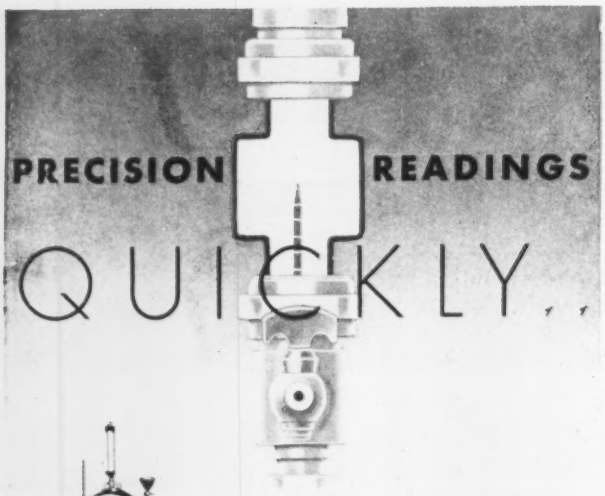
The last chapter discusses the troublesome problem of the determination of the temperature of gas flames. Several methods are discussed and advantages and disadvantages pointed out.

This small book should be a valuable addition to the library of one interested in this subject. It is too bad that it is so poorly put together mechanically.

—W. E. FORSYTHE, *Physicist, Lamp Development Lab., G-E Co., Nela Park, Cleveland, Ohio.* (2.06, 7.31-B)

Photoelements and Their Application. By BRUNO LANGE, translated by Ansel St. John. Reinhold Publishing Corp., New York, 1938. Cloth 9 × 5 inches, vi + 297 pages. Price $5.50.

This book is a translation of "Die Photoelemente und ihre Anwendung" published in two parts in Germany in 1936. It is one of the first, if not the first, book dealing almost exclusively with what the author prefers to call "Semiconductor Cells," more commonly known here as "Barrier Type Photocells." This type of cell, developed about ten years ago, has been found extremely useful in the construction of instruments for the measurement of light flux. The Semiconductor cells are noted not only for their ability to transform radiant energy into electrical energy and to maintain a current in an external circuit without the use of batteries



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Part I gives a historical introduction of photocells in general, and emphasizes the similarity between the Becquerel effect, photoconductivity and emissivity in crystals, barrier cells, etc. It discusses a number of theories which attempt to account for the photo effect in semiconductors, and describes in some detail the characteristics of the barrier type cells.

Some of the earliest experiments on photoemissivity were made with essentially what is known today as the selenium barrier cell, which was discovered in England by Adams & Day in 1876 and independently in the United States by Fritts in 1884. Both have attempted to use these cells for measuring light. Fritts made attempts to use them also for the reproduction of voice. The development of the modern cell, however, did not begin until 1928, and Dr. Lange, the author, played a considerable part in this development.

A large section of Part I (fully one half), is given to a detailed description of the physical properties of these cells. To those who use photocells, this section should be of great interest.

Part II deals with the application of these photocells in engineering, physics, chemistry, astronomy, etc. A large number of applications are given as well as description of apparatus. In this part there is also a short chapter on cell circuits—far too short, in our opinion, to be of much assistance to those unfamiliar with the cells.

An extensive bibliography is given in the ends of both Part I and Part II. The bibliography is carried to 1936. In Part II there are a few references of work published in 1936. It is unfortunate that neither the author nor the translator brought the book up to date by including the work that has been done since then.

On the whole the book should prove useful to those interested in the application of the barrier type photocells, both for the numerous examples that are given as well as for a general reference work of the field covered.

—ANDREW CHRISTY, *Head of research laboratory, G-M Laboratories, Inc., Chicago.* (7.1)

Gas Analysis. By A. McCULLOCH, H. E. and G. Witherby, Ltd., London, 1938. Cloth, 5½ × 8½ inches, 166 pages. Price 7s6d.

According to the author, this book is designed for students taking laboratory courses in fuel technology. It is divided into six chapters. The introductory chapter is concerned with mercury purification, apparatus maintenance, correction of gas volumes and sampling. The discussion of sampling, although brief, is adequate. The second chapter deals with the absorbents used for various gases and gives detailed directions for their preparation.

The initial portion of the third chapter takes up the solution of the simultaneous equations involved in combustion analysis. The final portion of this chapter describes the various methods employed in gas combustion analysis. In this discussion most of the emphasis is placed on the explosion method. The comparatively short discussion of the "hot spiral" and fractional combustion procedures might well have been expanded.

The next chapter describes the five types of gas analysis apparatus which the author considered essential. The descriptions of the Bone-Wheeler and Haldane methods are given in considerable detail for laboratory type models. On the other hand, the description of the Orsat apparatus is confined to the portable model. The author might have mentioned some of the improvements made in recent years in Orsat apparatus.

Chapter V gives detailed procedures for many of the specialized analytical problems common to the analysis of artificial combustible gases. The final chapter deals with measurements of the calorific values of the same type of gases.

In general the book is well written and is attractively bound and printed. Many of the analytical procedures described are the official methods adopted by the Association of Gas Referees and as such might have limited application in countries other than the United Kingdom. However, for the specialized field of fuel technology, the material included is adequate.

The reviewer suggests, in addition, that a title such as "Gas Analysis of Fuel Gases" would be more descriptive of the limited scope of this book.

—PAUL FUGASSI, *Asst. Prof. of Physical Chemistry, Carnegie Inst. of Technology, Pittsburgh.* (8.1)

Elektronen-Röhren. 4—Gleichrichter und Empfänger. (Rectifiers and Receivers). By H. BARKHAUSEN. S. Hirzel, Leipzig, Germany, 1937. Paper, 5⅞ × 9 inches, 291 pages. Price 9 RM. bound, 7.50 RM. unbound.

It occurs, occasionally, that a worker who has done fundamental work in a science also writes the definitive treatise on that field. Among such works are Wood's "Physical Optics" and Planck's treatise on "Heat." The four-volume series on electron tubes, of which this is the fourth and last, also belongs in that class.

It will be helpful to recall, for the reader, that each of the four volumes of this series covers one functional branch of the field of electron tubes. The first part covers the fundamental characteristics of tubes and of generally associated circuits. Vol. II is a treatise on amplifiers. Vol. III is a monograph on feed-back and oscillators. The volume presently reviewed is really a monograph on detectors but is built up on the basis of the underlying phenomenon involved — rectification. Also, the treatment extends into a considerable survey on the application of rectifiers, and mainly detectors, in modern receiving sets. Hence the title, "Rectifiers and Receivers."

In this volume as in the others the author gives a complete and comprehensive treatment. His manner is commendable in that he strives to give a

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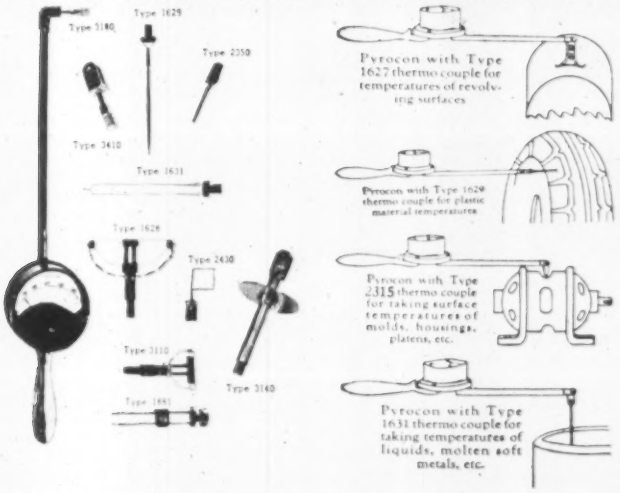
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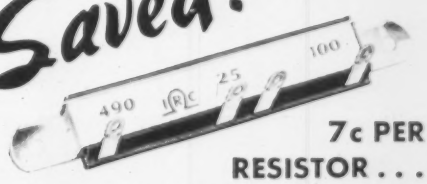

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clear physical picture of the phenomena involved. This, in a science where authors of texts are all too prone to jump at the out-set, into an involved equation and then to proceed through intricate mathematics to assumption-laden conclusions, is a welcome difference from the general run of electron-tube texts.

In general his analysis of rectifiers follows the method of attack used in his treatment of amplifiers. That is, to deducing first the no-load (open circuit) and full-load (short circuit) conditions. Characteristics at these extreme conditions are simply arrived at, and in terms of these as parameters other points in the operating range are evaluated. The analysis furthermore divides rectifiers into classes "A" and "B", analogous to the similarly designated classes of amplifiers, and correlates the characteristics of each rectifier class with the corresponding class of amplifiers. Finally, the characteristics of simple diode rectifiers are deduced first, and the more complicated detectors with three and more elements are broken down into equivalent diodes. A listing of the contents will show how logical is the breakdown of the material and how complete the treatment:

A. Unmodulated alternating currents; rectifiers.

I. Tubes without grids: 1) fields of application; 2) theory of circuits; 3) review of tube theory; 4) geometric problem of rectification; 5) the rectified voltage; 6) gradually curved characteristics; 7) parabolic tube characteristic; 8) exponential tube characteristic; 9) ideal rectifier, class B operation; 10) deductions and summary, class B; 11) experimental results; 12) measurements on B power supply rectifier; 13) non-sinusoidal voltage waves; 14) summary.

II. Tubes with grids: 1) plate circuit rectification; 2) grid circuit rectification; 3) rectification by current division. 4) summary.

B. Modulated Alternating currents receivers.

I. Theory of circuits; 1) side-band theory; 2) modulation by superposition; 3) modulation by interruption; 4) deductions from side-band theory; 5) selectivity and band width; 6) amplitude, phase, and frequency modulation; 7) summary.

II. Theory of tubes; 1) demodulation (detection); 2) Class A (small input voltage amplitudes); 3) Class B (large voltage amplitudes); 4) distortions due to bent detection characteristics, 5) distortion through inductive or capacitative audio impedances; 6) modulation—conversion to intermediate frequency (cross-talk); 7) general theory of frequency conversion; 8) summary.

C. Broadcast Receivers; 1) requirements; 2) sensitivity and disturbances (static); 3) amplification and detection; 4) selectivity and band width; 5) review of simple (tuned circuit) receivers; 6) review of super heterodyne receivers; 7) automatic volume control; 8) receiver A: "Volks receiver" (popular-price receiver); 9) receiver B—tuned circuit receiver; 10) receiver C—super-heterodyne; 11) summary.

The book has two major shortcomings. First is that the treatment is confined exclusively to high-vacuum thermionic tubes. Gas discharge tubes as rectifiers and detectors are left untouched. Also, there is a complete lack of bibliography. Although justification for both these lacks is earnestly argued in the preface, one is left with the feeling that a limited treatment, for both, but of the same high caliber as the text, would have been desirable.

On the whole, the bulk of the material in the volume is not original creation by the author. But the volume is not a mere summation or collection of work done in the field. Rather it is a thorough, comprehensible, integration of the best and latest in the technology of rectifiers and detection. With its many practical numerical examples, it is a most useful aid to the student being grounded in the fundamentals of the subject, and for the veteran worker in electronics an illuminating review.

—HYMAN OLKEN. (5,4)

Alternating Current Bridge Methods. By B. HAGUE, Isaac Pitman & Sons, London and New York, 1938. Cloth, 5⅜ × 8⅜ inches, xvii + 587 pages. Price $8.50.

The inspiration underlying this work is found in its final pages. As in the case of his classical book on Instrument Transformers (1936) the author closes with a short appendix on the subject of periodical literature, providing an analysis of the material from which his references have been drawn, and showing a graph of the annual output of such literature from 1880 to the present day. It is seen that the previous edition appeared at a time when newly published articles on the subject were at an all-time peak, and the art was being advanced at an unprecedented rate. Instead of resting on his laurels the author therefore has applied himself to the task of keeping his writings abreast of the time.

The casual reader would hardly suspect the phenomenal advances which have taken place in this specialized field within the six years since the third edition appeared; and a less thorough and painstaking writer might have thought these advances insufficient to justify a re-editing of his book. Dr. Hague, however, has assumed the task and has carried it out in meticulous detail, the result being a text-book which not only fulfills, but anticipates, the needs of the teaching, the research, or the testing engineer. "Not only does it record a widening range of applications but also important advances in fundamental theory. At the same time supplementary notes to the previous edition have been inserted in their proper place in the text, and more detailed explanations have been given of certain matters which experience has shown to need fuller treatment." Certain of the theoretical underlying principles of the alternating-current bridge circuits have been considerably expanded, and a complete classification of such circuits has been developed.

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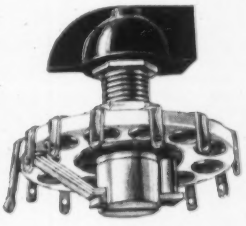

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new bridges and of many applications of old methods, particularly the versatile Schering bridge; and the subject of shielding has been treated more fully than in the earlier editions. While this book emanates from the university, its treatments are practical rather than academic; and in confirmation of this it may be mentioned that the volume had been in the reviewer's hands only a few hours when one of his associates found, in a circuit there described, the solution to a pressing problem in the selective measurement of mixed currents. Though the treatment is expressly defined as lying in the field of low and telephonic frequencies, it has been borne in mind that many bridge networks are adaptable to extremely wide frequency ranges, and their performance at radio frequencies has been given full consideration.

This book is profusely illustrated, there being nearly 200 specially-prepared and uniformly-delineated drawings. The vastness of the author's bibliographical resources is incredible; and the student making use of the references cited has at his command a complete index to a literature far more comprehensive than he could have dreamed existed. A total of 740 articles dealing with the theory, apparatus, construction, and use of a-c bridges has been referred to in the preparation of the text.

The author, in acknowledging assistance from correspondents and manufacturers, states that it has been possible to utilize only a small fraction of the information placed at his disposal; it must be conceded, however, that this "small fraction" has been selected with such insight that were all other writings on electrical measurement to be destroyed, the whole science of alternating-current bridge methods could be reconstructed on a working basis from the data preserved in this masterly work.

—PERRY A. BORDEN, *Research and Development Engineer, The Bristol Co., Waterbury, Conn.* (4-21)

Neon Tube Practice (Second Edition) By W. L. SCHALLREUTER. Chemical Publishing Co. of New York, Inc., 1939. Cloth, 5½ × 8¼ inches, 255 pages. Price $4.25.

Made necessary by the rapid growth of the industry, this second edition was not only revised but considerably enlarged. According to the preface, this treatise is intended for those interested in the sign trade and is written in a more or less popular way. This is recognized as a dangerous procedure but it seemed to the author to be the best way. Some errors due to this method are pointed out in what follows. Two new features dealt with at length are the hot cathode with its applications and the fluorescent tube.

The book is divided into four parts. The first 18 chapters is theoretical; it covers the general theory of gaseous conduction, giving some interesting word pictures of the ion and how it is produced. There is a chapter on the rare gases giving something concerning their properties, methods of obtaining them and the percentage of certain ones in the air. The next chapter takes up the question of the electrodes and shows what care is necessary to select the proper type for the different types of discharge tubes, pointing out some of the more common causes of failure. The electrodes must be outgassed. The necessity for the special transformer and choke coils is discussed and the last chapter gives a description of air pumps and methods of measuring the pressure in a tube.

In the second part, which deals with practical matters, the author goes into detail on the method of glass bending, making electrodes, pumping, and filling the tubes and gives some information about the necessity of thorough cleaning of the tubes and all the parts. Some of the various uses of discharge tubes both in sign lighting and other fields are discussed. This part ends with a chapter on methods of erecting and operating these signs.

The third part is concerned with failures of this type of tube due to various causes, viz., gas contamination, tube hardening, loss of gas, blackening of the tube, failure due to inadequate pumping, failure due to breakdown of the electrical system and further information concerning the necessity for keeping the tubes clean in every way.

In the last part special tubes are discussed such as Wriggle tubes that are sometimes produced by two different gases in the same tube and sometimes by the use of two different electrical supplies. Mercury vapor lamps are discussed, both the type used for sign lighting and that used for general illumination. There is some discussion of the present-day development of very high pressure mercury lamps. The present-day sodium are is described and some of its uses outlined.

There follows an appendix discussing patent literature and pointing out some problems that are left for the future.

The book is well illustrated with 30 plates and 28 figures. These illustrations are made up of pictures of installations and layouts and some show the equipment necessary for this type of work.

One might criticize the book and the criticism would follow from the author's statement that the book is written in a popular language. Some of the statements given by the book as fact, as stated on page 122 the statement is made that certain springs were discovered in Texas and in Canada that contract up to 5% boiling on page 13 and again on page 112 the author speaks of the high luminosity of neon light and at the same time says that it is mild and soft. In comparing the relative cost of neon tube sign lighting and incandescent lamp lighting to page 114 one feels that the relative maintenance cost is not quite fair to the incandescent lamp. Notwithstanding these errors and others of the same nature the book is an interesting discussion of the general subject of neon tube practice.

—W. E. FORSYTHE, *Physicist, Lamp Development Lab., G.E. Co., Nela Park, Cleveland, Ohio.*

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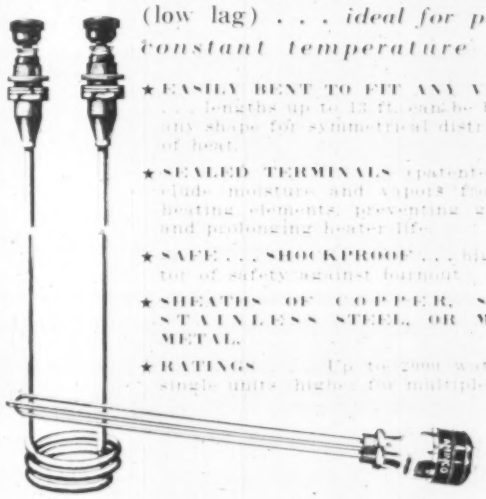

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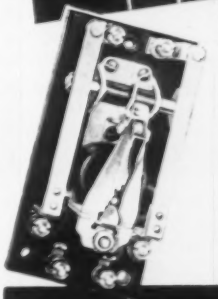

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